Power Engineering

DECEMBER, 1951

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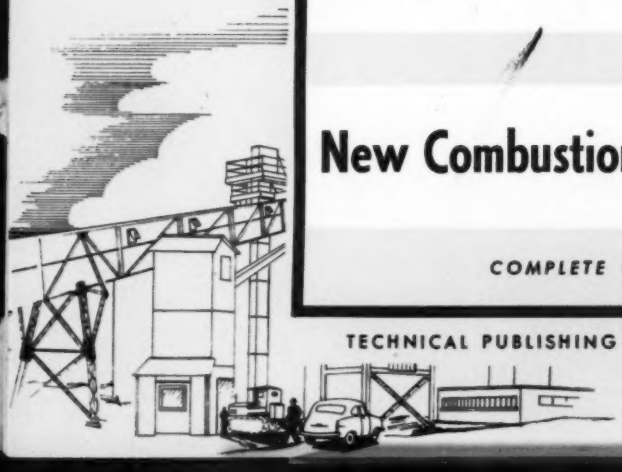

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ALL

• A 975,000-lb-per-hr vertical deaerating feedwater heater, mounted on its horizontal storage tank.

• Workmen fitting and welding internal baffling in a deaerating heater shell.

• Scarfing a head, preparatory to fit-up and welding.

ELLIOTT!

...from drawing board...to hydrostatic test

ELLIOTT
Deaerating Heaters

are (and always have been) distinctly and strictly an Elliott product, built throughout in Elliott shops to insure the positive and reliable performance that Elliott engineering has designed into them. We *know* every detail is *right,* before a unit is shipped, and that it will live up to the full expectations of ourselves and of its purchaser.

Elliott deaerating heaters require no maintenance. The tubular vent condenser of older designs is now replaced with an inlet spray unit and vent collecting hood located within the shell. Trays are of fabricated stainless steel. Non-corrodible metals are used wherever undeaerated water touches the metal. These are some of the latest developments in deaeration, fully covered in Bulletin N-16. Write for a copy.

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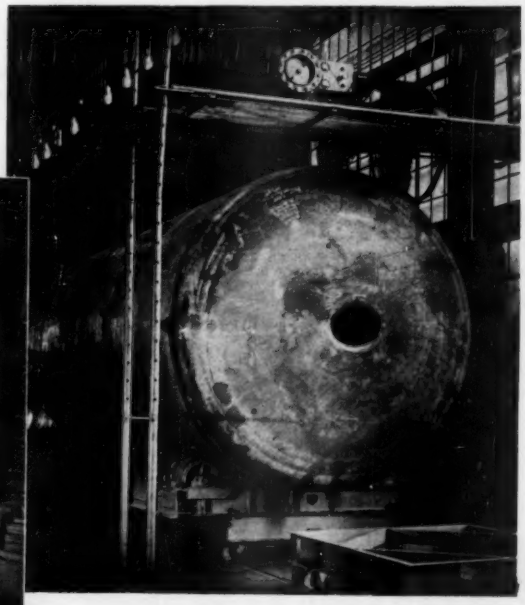
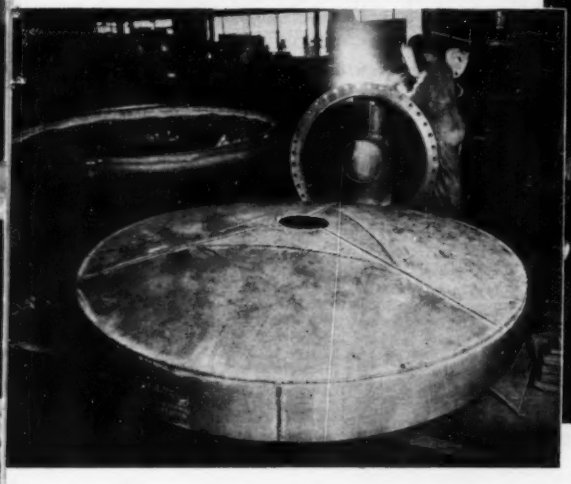
HALF CENTURY OF POWER PROGRESS 1901 EC 1951

H-1002

• A.S.M.E.-approved automatic welding is used wherever possible in fabricating deaerating heaters and storage tanks.

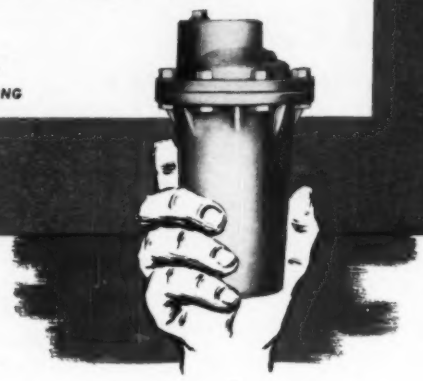
• Below, a stainless steel inner head.

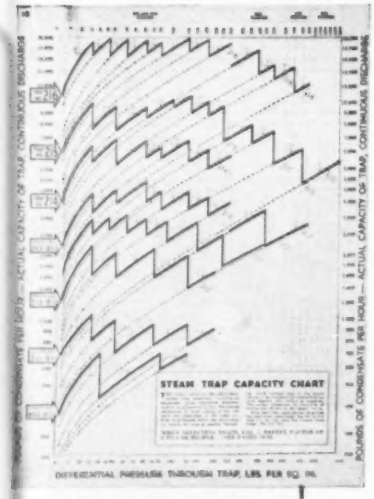




Only actual hot condensate capacities give a true picture of steam trap value

YOU KNOW THE CAPACITY WHEN YOU BUY AN ARMSTRONG





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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

This magazine was established in 1896 as Practical Engineer. The title was changed to POWER PLANT ENGINEERING in 1918, to POWER GENERATION in 1948, and to POWER ENGINEERING in May 1950. Rights reserved to above titles

December, 1951

VOLUME 55 — NUMBER 12

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Rural Co-operative Power Assn's Elk River Station 64
by A. C. Hunter
Built to serve a power co-operative system supplying 25,000 farmers, this new steam-electric generating station has initial capacity of 23,000-kw, in two generating units. It is designed for future use of North Dakota lignite and natural gas.

What About the Atomic Power Plant 70
by Andrew W. Kramer
Sooner or later — probably sooner — the atomic power plant is coming. When it does, we will not need to make thermal or cost comparisons of such plants with the best of our present and projected high-pressure, high-temperature steam cycles. The steam end of the stationary atomic power plant will probably be a medium- or even low-pressure, moderate temperature steam plant. And the entire fuel situation with atomic energy will not be comparable with that of our present fuel-burning plants. This article tells you why and explains the heat and cost relations we may expect in atomic power.

Graph Your Deaerator Heat Balance 73
by Fredric R. Alex
One of the trickiest calculations on steam power engineering is figuring a heat balance for a deaerating contact type heater. If you've tried it, you'll sigh with relief at the method shown here for making a simple diagram that will give you the answers quickly and accurately.

Packaging Aids A-C Generator Control 76
by W. P. Burt
Putting all your eggs in one basket is generally considered poor judgment. But in the case of excitation and other controls for a-c generators, it may be very good judgment. That's what packaging means here and the author shows not only why but how it's done.

Waukegan Saves 74% by Deionizing Make-up 78
Saves 74% of what, you ask? (That's what the title was supposed to make you ask.) Well it's 74% of the cost of treating water for old and new generating units at Waukegan Generating Station of Public Service Co. of Northern Illinois. New treatment system costs and performance given in detail.

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Bokaro—*Correction*

Through a misunderstanding on the part of one of the members of our editorial staff, on the contents page of the October issue, we wrongly stated that Bokaro Station was backed by ECA. This is not so. The project was financed with the help of the World Bank, otherwise it is a project of the Government of India, managed by its Damodar Valley Corporation.

Regular Departments

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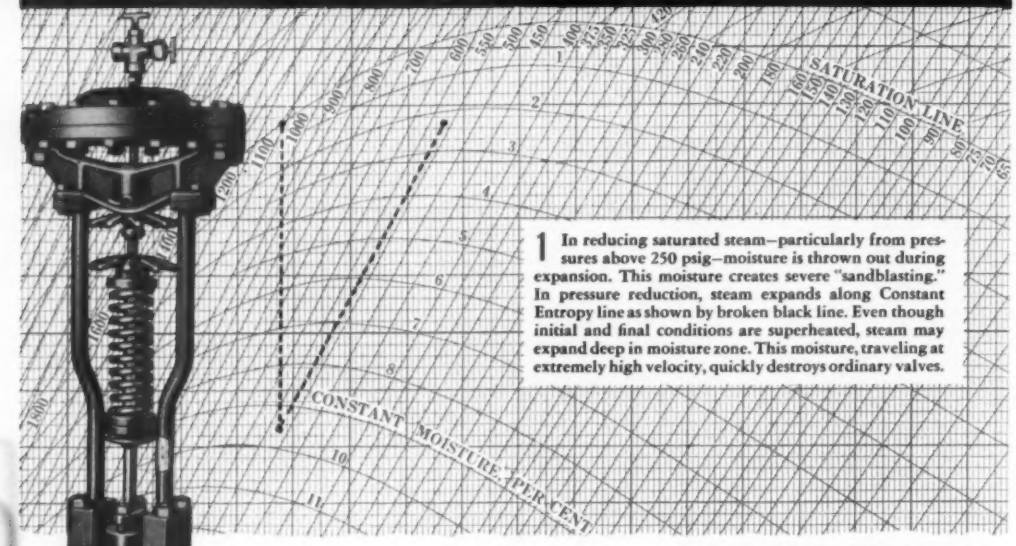
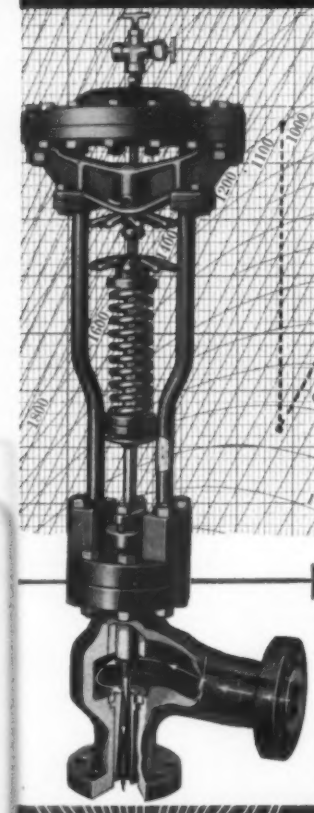
The only magazine devoted exclusively to the engineering interests and practical problems of power engineers

Swartwout V-10 Flow Regulating Valves slash maintenance costs in systems with high pressure drop or flashing condensate



1 In reducing saturated steam—particularly from pressures above 250 psig—moisture is thrown out during expansion. This moisture creates severe "sandblasting." In pressure reduction, steam expands along Constant Entropy line as shown by broken black line. Even though initial and final conditions are superheated, steam may expand deep in moisture zone. This moisture, traveling at extremely high velocity, quickly destroys ordinary valves.

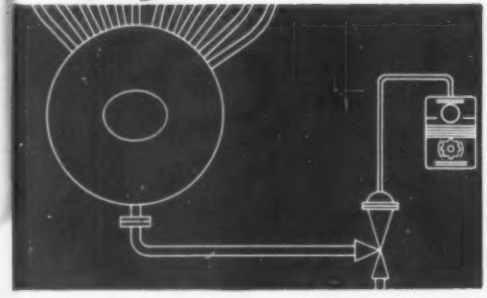
Chart from *Thermodynamic Properties of Steam* by Keenan & Keyes. Reproduced by permission of John Wiley & Sons, Inc., Publishers



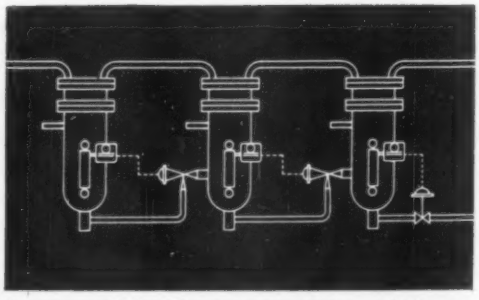
2 Swartwout V-10 valves are scientifically designed to handle liquids at high pressure drops and also under *flashing conditions.* All direct impingement is eliminated and longer valve life is assured two ways—by better flow design, plus use of materials specifically selected for the service involved. As a result, *Swartwout V-10 valves outperform other valves in similar service.*

Swartwout

POWER PLANT EQUIPMENT



3 High pressure boiler blowdown service is extremely rigorous. When closed, there is full pressure drop across valve; when open, high velocities and flashing rapidly increase line loss and decrease the allowable drop across the valve. The variations in pressure make this service critical since valve must handle all conditions.



4 In saturated liquid drainage service, such as on high pressure extraction type heaters, water at saturation temperature flashes into steam when pressure is reduced. Exclusive scroll inlet and gradually expanded straight outlet of V-10 valve design permit a sliding action instead of direct impingement thus preventing corrosion-erosion. A-4096

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ENGINEERS' PREVIEW

THE PART played by the engineer in creating the present way of living has established engineering as one of the most important professions in today's world, Ira P. Macnab, president of the Engineering Institute of Canada and general manager of the Public Service Commission of Halifax, Nova Scotia, told the semi-annual meeting of ASME at Toronto.

"The last one hundred years has seen a tremendous impetus in engineering activities with a continual broadening of the work which the engineer is called upon to do," said Mr. Macnab. "We are now at the threshold of the atomic age. What may happen to our civilization rests broadly in the hands of the scientist, the engineer and the economist. It is our duty as senior men to accept this responsibility and face the challenge that goes with it. While a few engineers have become great public men in proportion to our numbers, there is great doubt if we are carrying our share of the load," he declared. He questioned whether the present engineering curriculum is broad enough to equip engineering graduates for the wider duties of citizenship and the increasingly executive role in industry that they are being called upon to assume.

★ ★ ★

CMP became a reality to industry in July. For the third quarter of the year, the Defense Electric Power Administration (Depa) ordered the new system of material allocations into effect for major power plant additions and minor requirements. Manly Fleischmann, director of NPA, was nominated to head up the Defense Production Administration as well and a program was instituted for changing DO orders used in the first half of the year into CMP orders for allocation of controlled materials. Controlled materials are copper, aluminum and steel in the various forms and shapes listed in CMP Regulation 1.

There have been changes and new appointments in the various branches of the Defense Production Administration and the various branches concerned with supervision over engineering materials. During the past month it has not been possible to draw any conclusions on how the new plan is working or may work in the future. As this is written, the Korean cease-fire talks have not yet resulted in anything more than pious hopes and some observers feel that, if they result in a Korean peace, a good deal of the steam may leak out of the mobilization effort. Whether American business and the American people generally can and will accept controls for mobilization still remains to be seen.

It is obviously impossible in a monthly magazine such as POWER ENGINEERING to keep readers informed of the daily progress of any such program as that now underway, especially when it is just getting started. Moreover, to comply with the various regulations of the program is primarily a management function or an industry function. What you can do as an engineer is determined largely by factors of supply and requirement that are not strictly engineering.

So if you must keep in close touch with every detail of the mobilization program, your detailed day-by-day information will come from the National Production Authority or one of its branches. You can always apply to the nearest field office, a list of which will be supplied by the National Production Authority, Office of Public Information, Room 5004 Commerce Building, Washington 25, D. C.

THE MUCH-MALIGNED coal-burning locomotive has received a boost recently from the president of one of the nation's principal railroads. He said the economy and reliability of the modern, coal-burning, steam locomotive cannot be bettered by any other existing type of railroad power, and then gave figures from his own railroad to prove it.

R. H. Smith, head of the Norfolk and Western Railway Co., told the 14th Annual Fuels Conference that a study of the 23 principal railroads in this country, including his own, showed that the N & W's 64,766 gross ton-miles-per-train-hour in 1950 surpassed any of the other 22 railroads for that year. This year's results thus far indicate that the N & W will better its own figures and will again top the other 22 railroads, Mr. Smith declared.

Mr. Smith said the N & W's present activities in developing other types of coal-burning locomotive stem from its realization that the conventional steam locomotive boiler has just about reached its limit in boiler pressure and cannot go appreciably higher. Barring unforeseen difficulties, it expects to have a coal-burning, steam-turbine, electric-drive locomotive undergoing road tests on its line before the end of 1952.

Plans for this locomotive were developed together with the Babcock & Wilcox Co., Westinghouse, and Baldwin Locomotive. Preliminary tests have been completed and construction has begun. The locomotive will utilize a water-tube boiler, generating steam at 600 psi, 900 F. The N & W has also joined the group sponsoring development of the coal-fired, gas-turbine, electric-drive locomotive.

★ ★ ★

FEDERALESE is indispensable in Washington. Remember that subtle and clever book some time ago called Federal Prose: How to Write In, And/Or For Washington, by two refugees from the government departments? Well, here are some more clever examples of Federalese as presented recently by Jerry Kluttz in his *Federal Diary* in *The Washington Post*.

A Program — Any assignment that can't be completed by one phone call.

Channels — The trail left by an interoffice memo.

Status Quo — This mess we're in.

To Expedite — To confound confusion with commotion.

Expediter — One who does same while riding fast trains and staying at good hotels.

Co-ordinator — A guy who has a desk between two expediters.

Conference — A place where conversation is substituted for the dreariness of labor and the loneliness of thought.

Conference — A conference is a group of people who individually can do nothing but who can meet collectively and agree that nothing can be done.

A Modification of Policy — A complete reversal which nobody admits.

Give Us the Benefit of Your Present Thinking — We'll listen to what you have to say as long as it doesn't interfere with what we've already decided to do.

An Expert — An expert is a person who avoids all the small errors as he sweeps forward to the grand fallacy.

Confidential Memorandum — There wasn't time to mimeograph this bundle of confusion.

AS THE FIRST PHASE of a program to link the main cities of India by radio telephone and radio telegraph, that nation's Posts and Telegraphs Department has ordered 16 three-kilowatt, type-MW high-frequency transmitters from the Westinghouse Electric International Co. The apparatus will supplement existing land lines and relieve congested communications service between Bombay, Calcutta, Madras and Delhi. It is expected to eliminate many of the maintenance problems on India's 100,000 miles of land lines. Twelve of the 16 transmitters will be supplied with multiplex equipment which will enable each unit to carry four radioteletype messages simultaneously. Terminal equipment will tie in radio communications with land lines which now serve the areas surrounding the four cities.

★ ★ ★

IN THE WARM-UP WAR — World War I — (Oh, THAT war!) — all we used to hear from the grizzled old regular Navy men was: "The Navy used to have wooden ships and iron men but now we got iron ships and wooden men!" Some of the young fry tell us they heard somewhat the same thing in the Navy during World War II. Well, anyway, the wooden men of World War I and II didn't do so badly with their iron ships.

Of course, the wooden ships *needed* iron men, as F. F. Kaiser points out in a most interesting article in *Shipyard Bulletin* of Newport News Shipbuilding and Dry Dock Co., March–April 1951 issue. They're about all gone now, he says — the wooden ships, that is — and it is just as well. Smaller than the steel vessels of today, lacking modern dependability, comfort and sea-keeping quality, they offered instead a greater measure of color and nautical personality. It is said that men who sailed such ships were closer to their craft than are the seamen of today and that may be true.

Mr. Kaiser, drawing from the records of the Newport News Shipyard, goes on to describe a number of the last of the wooden ships, particularly the big schooners that sailed up and down the Eastern coast and, in fact, all over the oceans. The fact is, when the *Engineers' Preview* editor was a boy, it was no uncommon sight, when sailing in Massachusetts Bay, or off Newburyport or Gloucester, to see 3- and 4-masted schooners beating down the coast with loads of lumber from Maine and granite from Rockport.

We were surprised to learn from Mr. Kaiser's article that the biggest wooden 6-masted schooner in the East Coast coal trade was the *Wyoming* which was in service until as late as 1924, when she was wrecked near Pollock Rip.

If you want a whiff of southeast breeze or dock mud and perhaps a barnacle or two, just look at the pictures in Mr. Kaiser's article. Oh, yes, Newport News builds and repairs ships and also builds big hydraulic turbines, in case you had forgotten it while smelling the salt breeze.

★ ★ ★

THE FABULOUS oil fields of Alberta, which alone supply one-third of Canada's current petroleum requirements, have raised that country's annual crude oil production to nearly one-half of its total needs. Contrasting this with domestic production which amounted to only seven per cent of consumption in 1947, the year of the discovery of the western oil deposits, Dr. Oliver B. Hopkins described the effect of this development on the economy of the west and Canada as a whole, in a paper before the ASME at Toronto.

IN ONE of the largest office leasing transactions in New York City in 1951, The Babcock & Wilcox Company, nation's largest producer of steam generators and related equipment, has taken five entire floors totalling approximately 120,000 square feet of space in the new fully air-conditioned 32-story Chrysler Building East, New York.

★ ★ ★

IMPROVED SILICONE resins for electric insulation will bring about important changes in the renewal parts and service shop businesses of the electrical industry, it was forecast by H. F. Jones of GE's Chemical Department. Although early silicone resins lacked compatibility with organic resins, silicone resins have recently been developed with the ability to mix with and improve the properties of a wide variety of organic resins and compounds. These silicone blending resins, of which General Electric SR-82 is an example, have opened up a whole new field of investigation. With many applications in the electrical industry in need of insulation with higher heat resistance, the combination of silicone and organic resins can add a greater safety factor in motors, generators, and transformers at a minimum of cost. By addition of varying amounts of silicone resins, it is conceivable that insulating resins tailored to specific temperature requirements will be produced.

★ ★ ★

NEW PROTEIN spot digestant for dry cleaners effectively "eats and digests" stains from clothing, says Pabst Brewing Co.

★ ★ ★

AFTER SPENDING three years and almost a million dollars on research, the Du Pont Co. has developed a new and economical way to add its synthetic rubber, neoprene, to paper. Instead of coating or saturating the finished paper, as in older methods, the neoprene is now added in latex form to the pulp just before it is made into paper. The result is a new family of low-cost specialty papers made directly on the paper machine. Outstanding advantages of the new papers are wet strength, chemical resistance, and all-around improvement in physical properties. In the industrial field neoprene treated paper has undergone successful field trials in such applications as gasket paper, multiwall bag paper, wrapping paper, box board, and industrial filter paper.

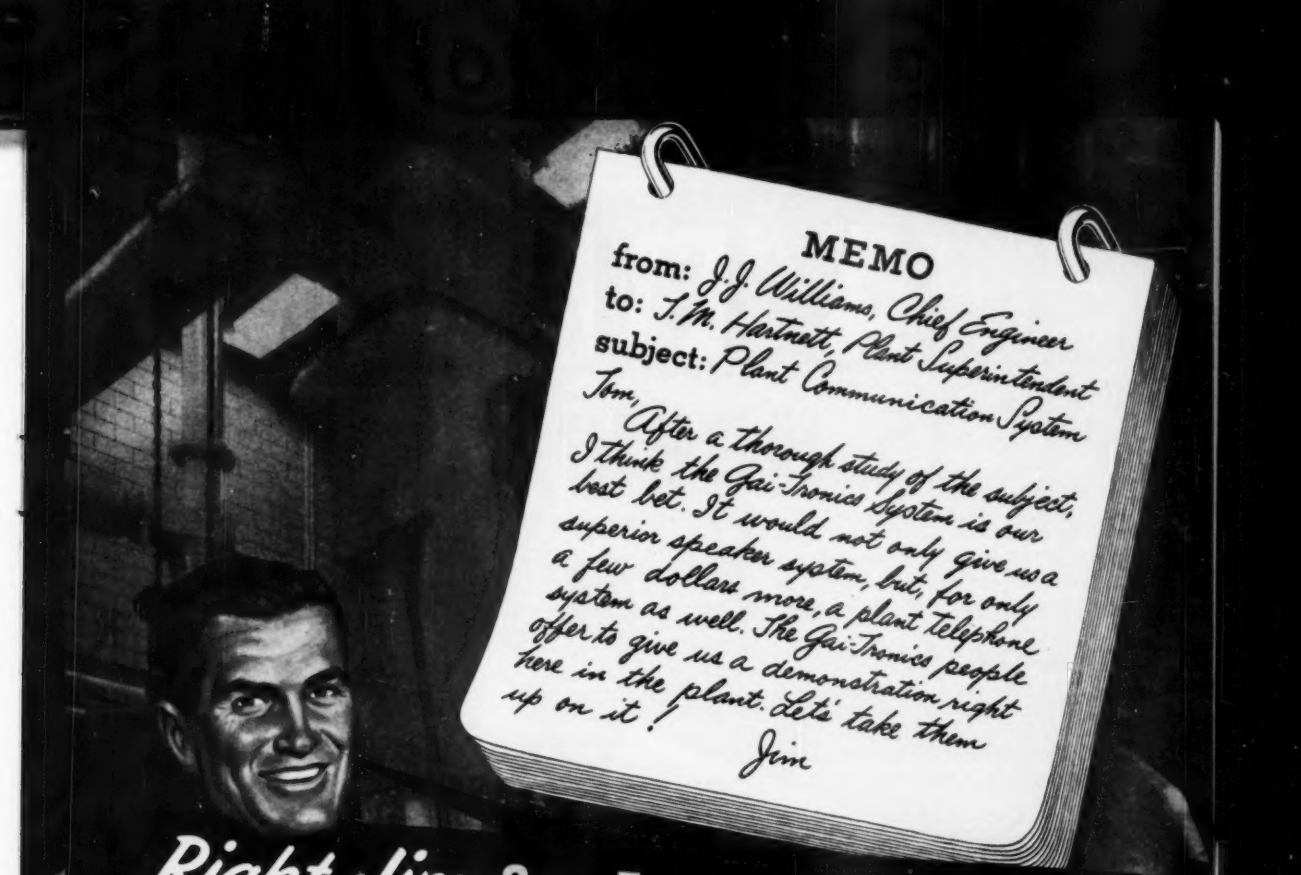
★ ★ ★

HYDROELECTRIC plants are being built by two private utility companies at outlets of new pressure tunnels that will transmit more water to New York City. Power revenues will help pay costs to both city and utilities.

★ ★ ★

TRAINING COURSE covering the six emergency measures necessary to make an injured person comfortable until he can receive the attention of a physician has been prepared by the Department of Technical Services of the American Petroleum Institute.

Details of the course are contained in a First-Aid and Safety-Training Guide, which is now being made available to the oil industry and other interested purchasers. The Guide also outlines the petroleum industry's program for the safety of individual employees, as well as the personal protective equipment available and its functions. Copies may be purchased from American Petroleum Institute, 50 West 50th Street, New York 20, N. Y.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from: J.J. Williams, Chief Engineer
to: T.M. Hartnett, Plant Superintendent
subject: Plant Communication System
Tom,
After a thorough study of the subject, I think the Gai-Tronics system is our best bet. It would not only give us a superior speaker system, but, for only a few dollars more, a plant telephone system as well. The Gai-Tronics people offer to give us a demonstration right here in the plant. Let's take them up on it!
Jim

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Only by choosing a GAI-TRONICS Power Plant Communication System, can you get a *complete* system—far more versatile than an ordinary public address hookup with an unhandy, separate intercom.

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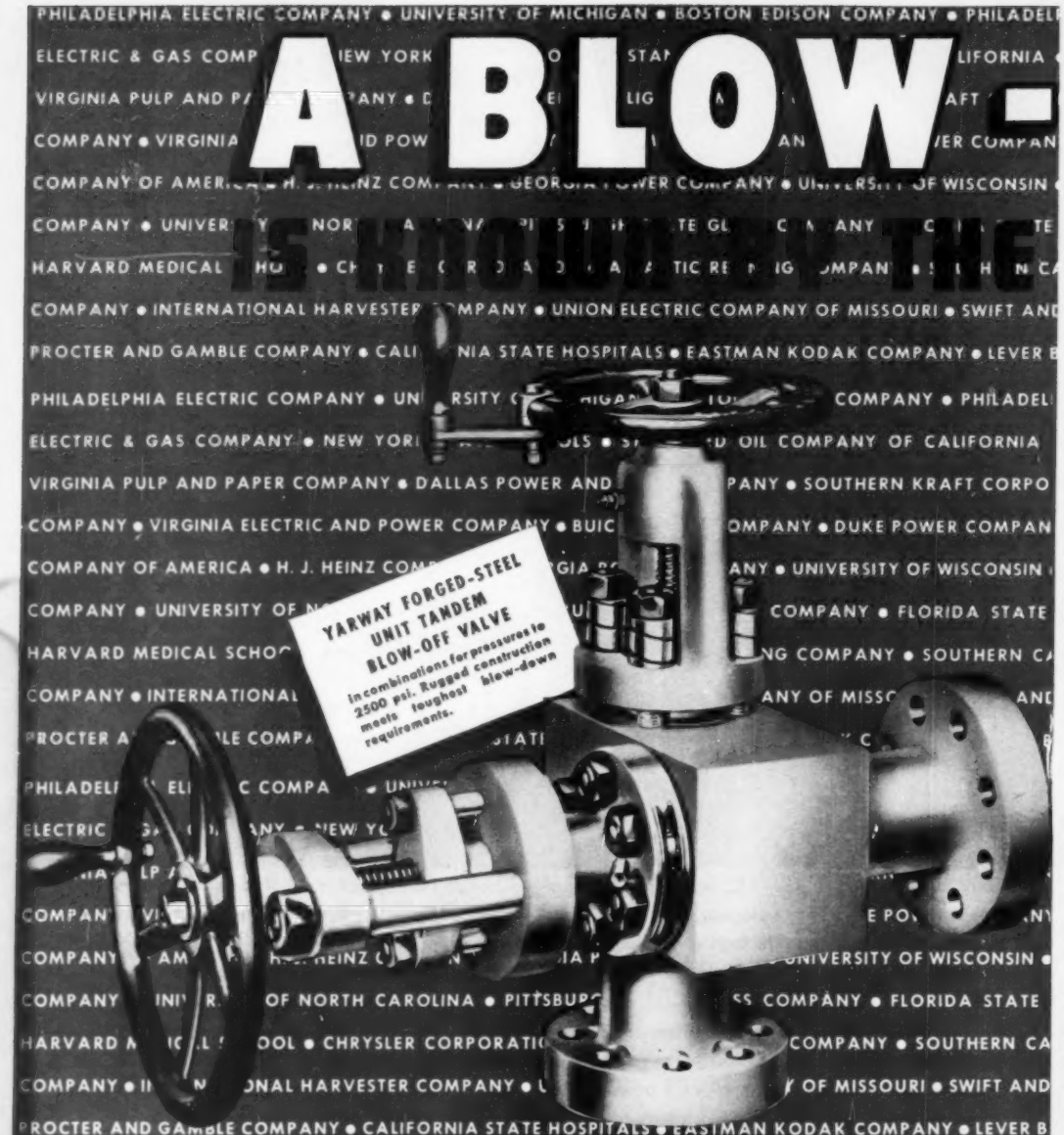
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R. J. REYNOLDS TOBACCO COMPANY • CARNEGIE INSTITUTE OF TECHNOLOGY • HUMBLE OIL AND REFINING

HOSP ... NY • ... SITY ... Y •

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COMPANY • FLORIDA POWER COMPANY • ARMOUR AND COMPANY • UNIVERSITY OF PENNSYLVANIA •

OFF VALVE

BOILER SAFETY PROTECTS

When buying blow-off valves, weigh the significance of these two facts:

More than 15,000 boiler plants in the United States and other countries are equipped with Yarway Blow-Off Valves . . . Some of them for nearly 40 years. *Among high pressure plants, 4 out of every 5 in the United States are Yarway-equipped.*

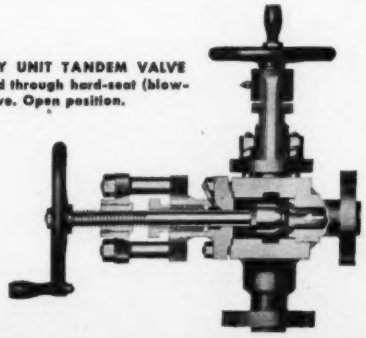
Design, metallurgy, workmanship and service are the reasons. It was Yarway that brought out the famous Seatless Valve, teamed it with a stellited hard-seat valve in a common forged-steel body to make the popular Unit Tandem. Yarway has also made available metallurgical improvements to withstand the chemical reactions of acid wash as well as the mechanical wear of boiler blow-down.

Yarway continues to pioneer and improve blow-off valves and blow-off valve service for both high and low pressure applications.

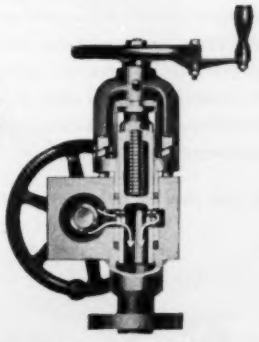
On new boilers, replacements or modernization, make sure you specify Yarway Blow-Off Valves. Any boiler manufacturer will supply them on your specification.

Bulletin B-424 gives you the full story on pressures to 400 psi. Bulletin B-433 for higher pressures. Both are free. Write . . .

YARNALL-WARING COMPANY, 114 Mermaid Ave., Philadelphia 18, Pa.



YARWAY UNIT TANDEM VALVE sectioned through hard-seat (blowing) valve. Open position.



YARWAY UNIT TANDEM VALVE sectioned through seatless (sealing) valve. Open position.

Only Edward Has Integral Seats

FOR ALL HIGH PRESSURE–HIGH TEMPERATURE REQUIREMENTS

Pioneer in the valve industry in the use of Stellite hard facing for seats and disks, only Edward has the experience and the intricate equipment to build trouble-free extreme service valves with integral hard facing in a full size range.

No more leakage between valve seats and bodies, no more loosened or distorted seats, regardless of pipe size, service, or valve type.

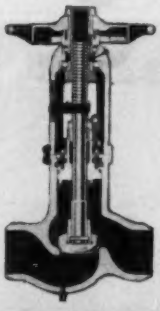
For high pressure—high temperature service, integral valve seats pay for themselves a dozen times over. So, Edward makes them standard construction in the higher temperature ranges, optional for moderate temperature service, and has them available in globe, angle, gate, non-return, instrument and other valve types in a full size range. Integral seats are leakproof seats. There are no threads to corrode—no points for erosion to start—no welds on seat rings to fail. An integral seat valve in a clean piping system needs no maintenance—no replacement.

For sizes, types and ratings write for Edward catalog 104.

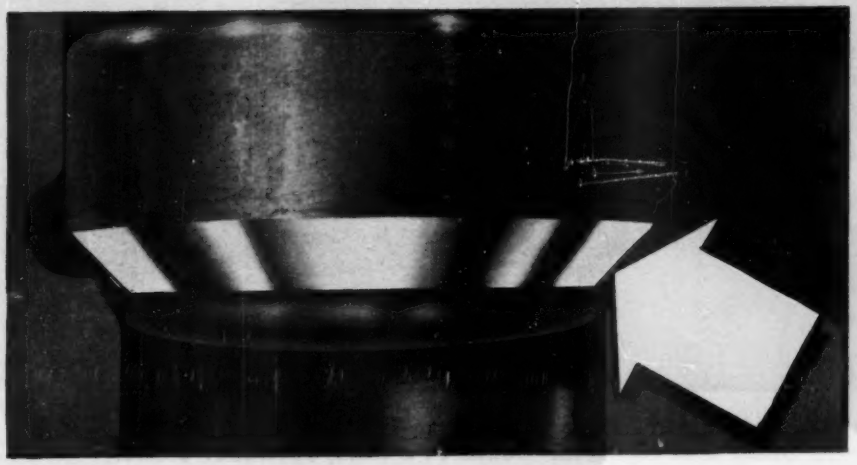
EDWARD—"BIRTHPLACE OF BETTER VALVE DESIGNS"

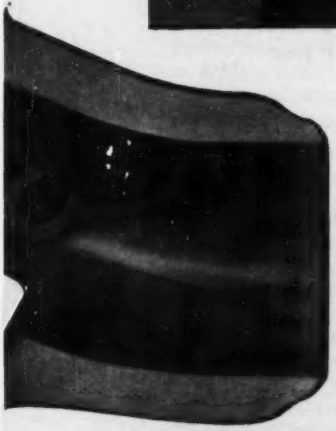
In a Full Range of Valve Sizes

Specify Edward valves with integral, hard-surfaced seats across the board, for Edward and only Edward gives you this permanently tight, leak-proof feature in every steel valve size from ½ in. to 16 in.



See how the Edward integral seat is part and parcel of the valve body itself. Stellite is applied by weld deposit on the machined valve body seat area. The entire body is then heat treated to remove stresses and prevent distortion. Next, the seat is machined to mirror-smooth finish and exactly mated to the hard faced disk.





FEATURES LIKE THIS SAVE YOU TIME, TROUBLE AND MONEY...

IT PAYS TO SPECIFY EDWARD VALVES

WITH AN INTEGRAL SEAT THERE ARE NO LEAKS BETWEEN SEAT AND BODY

Another Product

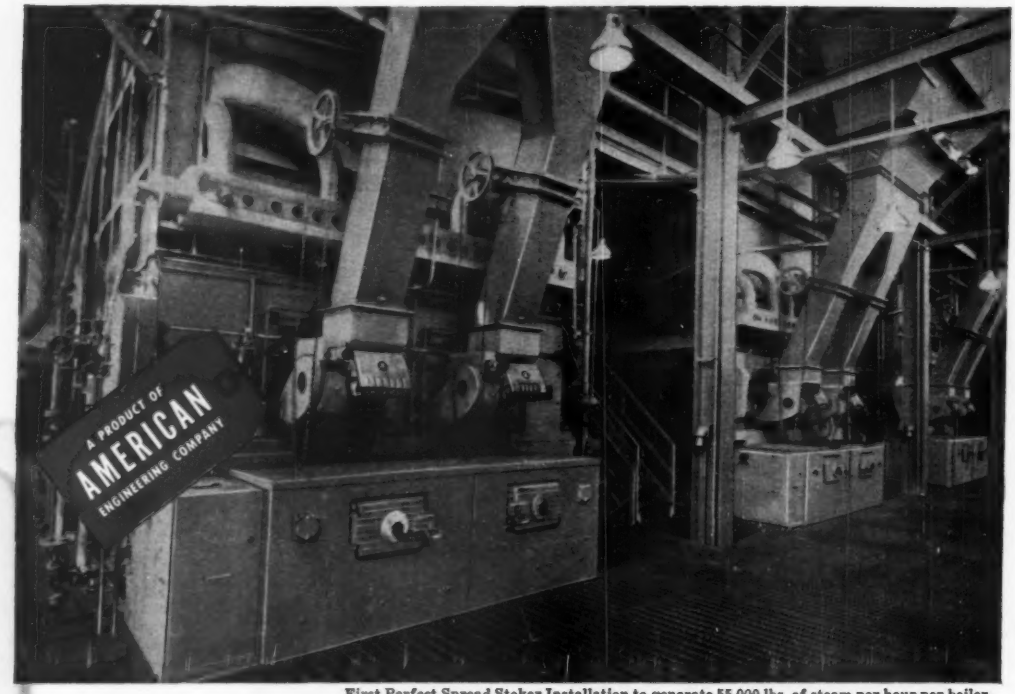
Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

220 West 144th Street

EAST CHICAGO, INDIANA

1... 2... and now a 3rd order for



First Perfect Spread Stoker Installation to generate 55,000 lbs. of steam per hour per boiler.

Day and night, for weeks at a time, Spreader Stoker continuously releases 700,000 B.T.U. per hour per square foot of active grate area

1 IN THE FALL of 1949 a very well known corporation installed three AE Perfect Spread Stokers to generate 55,000 lbs. of steam per hour each in one of its midwest plants.

2 Months later the Company needed more steam from larger boilers in another plant where the existing stokers had been designed to burn 12,300 B.T.U. per pound coal. Over the years, however, the available coal dropped to as low as 9500 B.T.U. per pound so the plant could not carry the required load.

On the basis of proved performance, an AE Perfect Spread Stoker was installed as a replacement... and here's the record:

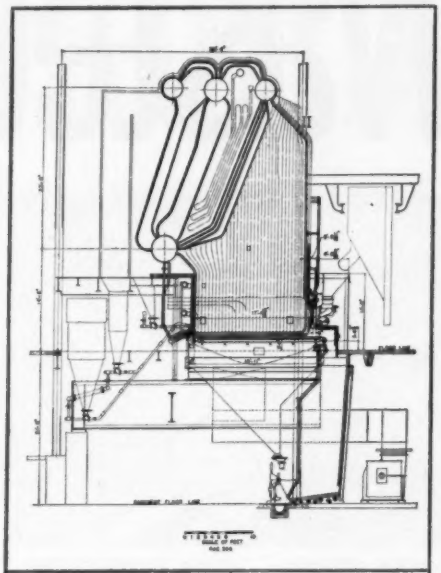
The Perfect Spread has averaged better than 180,000 lbs. of steam per hour—24 hours a day—7 days a week for weeks on end. Efficiency is about 84% and the release rate exceeds 700,000 B.T.U. per sq. ft. of active grate area per hour! In terms of sustained results per sq. ft. of grate surface this is probably the highest duty spreader stoker installation in the world. With an increased manufacturing load they now find they can carry 200,000 lbs. per hour.

3 And now, again on the basis of performance, the same company has ordered two more duplicate Perfect Spread Stokers.*

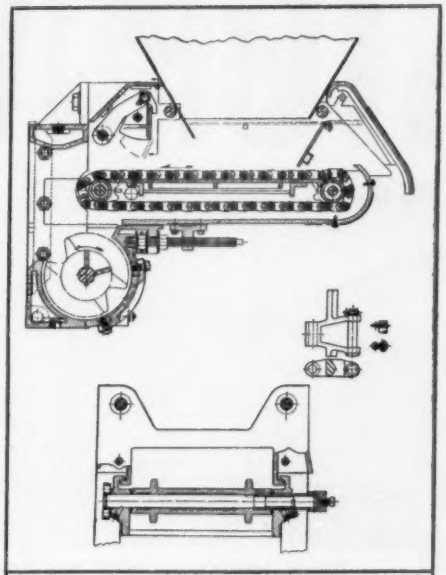
AE Perfect Spread Stokers burn high and low ash coals with practically equal efficiency. They assure positive, continuous coal feed and unbe-

*AS THIS MESSAGE WAS GOING TO PRESS, THE ABOVE COMPANY PLACED A FOURTH ORDER FOR A PERFECT SPREAD STOKER.

PERFECT SPREAD STOKERS



Second larger installation of Perfect Spread Stoker actually giving 200,000 lbs. of steam per hour from a single boiler.



NON-CLOGGING CONVEYOR FEEDER: Coal enters feeder from hopper, and is conveyed positively, continuously and uniformly forward. Coal is not fed in slugs.

lieveably even distribution. *They never clog on wet coal.*

Perfect Spread Stokers have a capacity range from 8,000 to 500,000 lbs. of steam per hour... coal feeders are adjustable from 50 lbs. to 7500 lbs. of coal per hour. Mail coupon today for a copy of the Perfect Spread Stoker booklet and for a reprint of a new report on large spreader stokers. Also, if you are now considering a boiler in capacities from 300,000 to 500,000 lbs. of steam per hour, let's arrange to get together and discuss cross-firing.

WON'T CLOG ON WET COAL

AMERICAN ENGINEERING

COMPANY

PHILADELPHIA 25, PENNA.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

American Engineering Company
2408 Aramingo Avenue
Philadelphia 25, Penna.

Gentlemen: Kindly send me free copy of Perfect Spread Stoker booklet and new stoker report ☐. I should like to discuss cross-firing ☐.

Name_____ Title_____

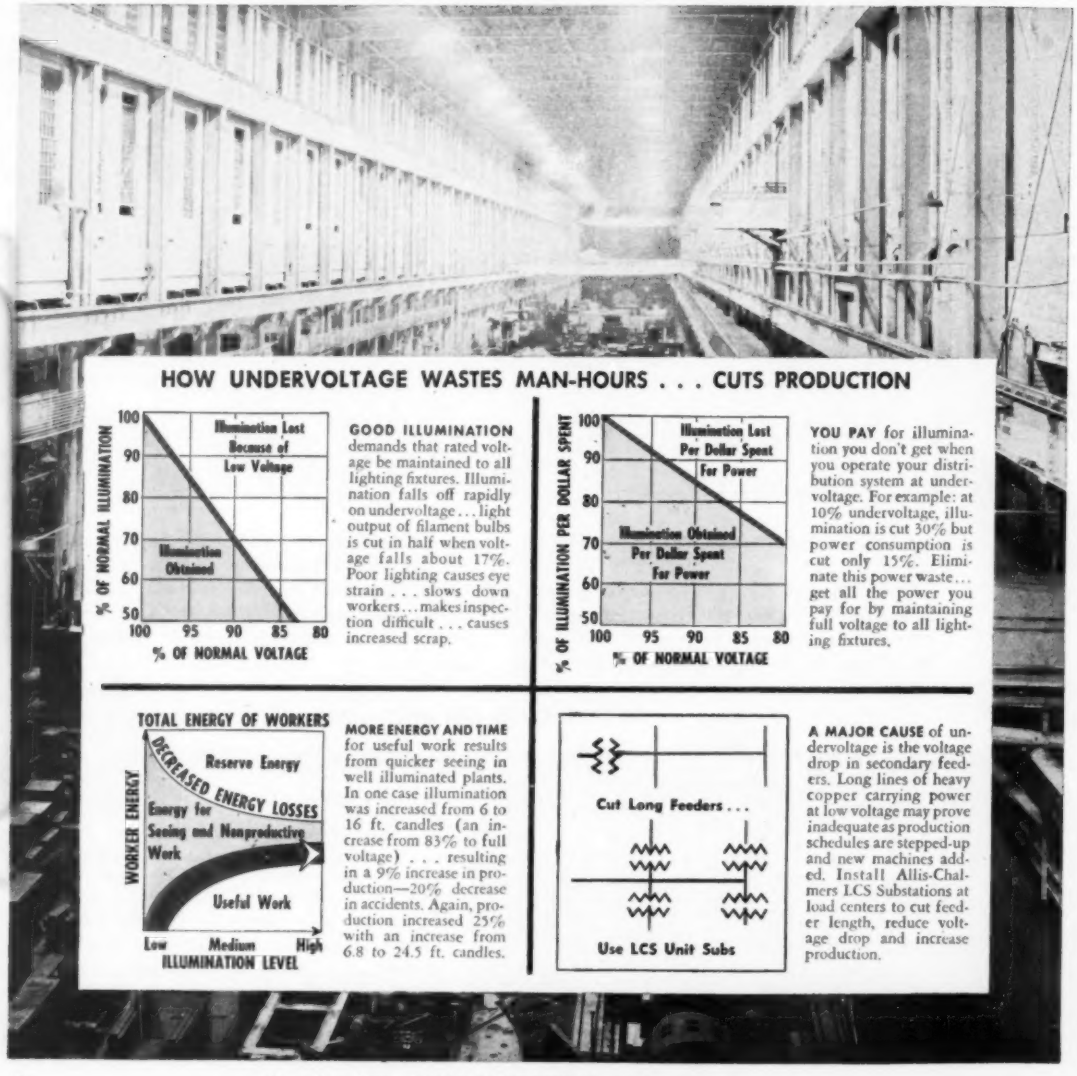
Company_____

Address_____

City_____ Zone____ State____

Allis-Chalmers

STOP Wasted



HOW UNDERVOLTAGE WASTES MAN-HOURS . . . CUTS PRODUCTION

GOOD ILLUMINATION demands that rated voltage be maintained to all lighting fixtures. Illumination falls off rapidly on undervoltage . . . light output of filament bulbs is cut in half when voltage falls about 17%. Poor lighting causes eye strain . . . slows down workers . . . makes inspection difficult . . . causes increased scrap.

YOU PAY for illumination you don't get when you operate your distribution system at undervoltage. For example: at 10% undervoltage, illumination is cut 30% but power consumption is cut only 15%. Eliminate this power waste . . . get all the power you pay for by maintaining full voltage to all lighting fixtures.

MORE ENERGY AND TIME for useful work results from quicker seeing in well illuminated plants. In one case illumination was increased from 6 to 16 ft. candles (an increase from 83% to full voltage) . . . resulting in a 9% increase in production—20% decrease in accidents. Again, production increased 25% with an increase from 6.8 to 24.5 ft. candles.

A MAJOR CAUSE of undervoltage is the voltage drop in secondary feeders. Long lines of heavy copper carrying power at low voltage may prove inadequate as production schedules are stepped-up and new machines added. Install Allis-Chalmers LCS Substations at load centers to cut feeder length, reduce voltage drop and increase production.

Unit Substations

Manhours!

By Improving Illumination

BOTH MACHINERY AND PERSONNEL gain efficiency when you install unit substations to correct undervoltage. That's because no worker can do his best *unless* his job is well lighted . . . no electrical equipment gives top performance *unless* it operates at proper voltage.

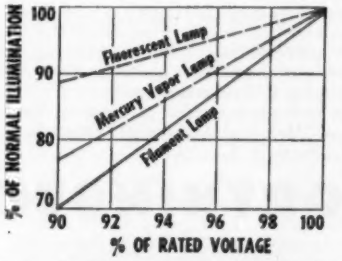
Filament bulbs, for instance, give 15% less than rated light when voltage falls only 5%. On undervoltage, fluorescent tubes and mercury lamps give less than rated light, are difficult to start, may flicker and go out. And when you operate at undervoltage, you are paying for power you're not using.

Eliminate power waste . . . manhour loss. Workers are more efficient, produce more work of better quality when illumination is adequate. Put *all* the power and manhours you're buying to work by maintaining proper voltage to all equipment. Install Allis-Chalmers LCS Unit Substations at load centers and eliminate long runs of expensive low voltage cable. Allis-Chalmers LCS Load Center Unit Substations are neat, compact, easy to install and provide protection to personnel.

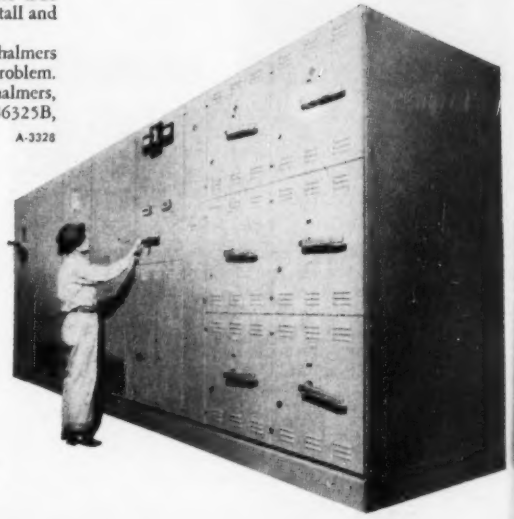
You can count on the cooperation of experienced Allis-Chalmers substation engineers in working out your distribution problem. Get in touch with your A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for bulletins 11B6285A, 11B6325B, and 11B6895.

A-3328

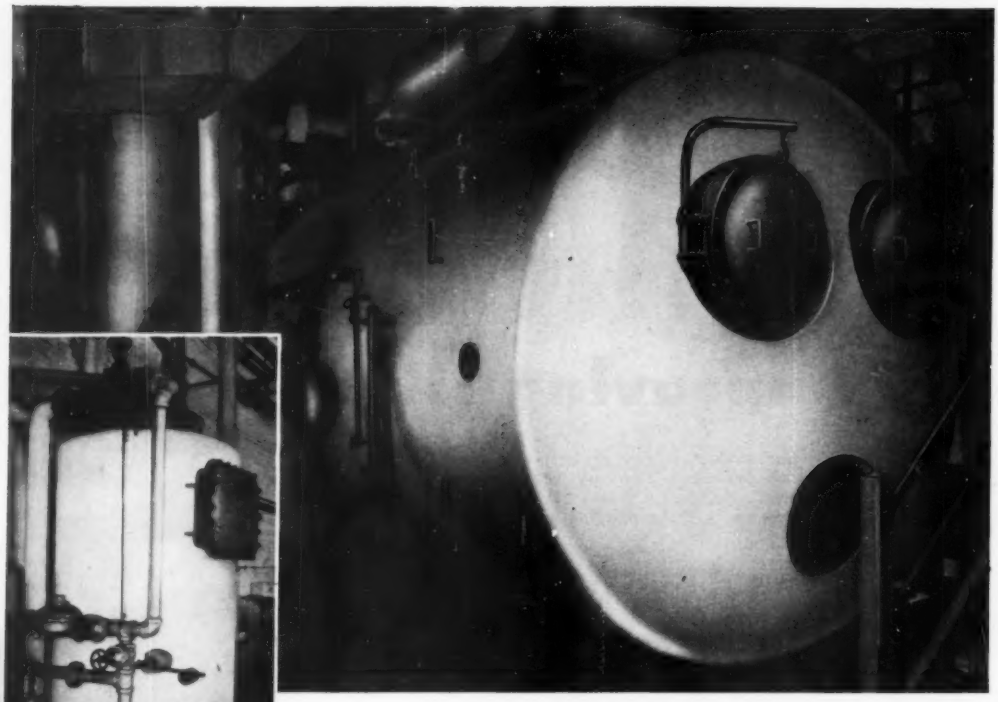
LCS Unit Substations

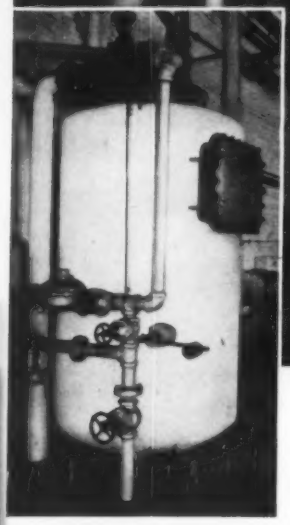


Undervoltage reduces the light output of filament, fluorescent and mercury vapor lamps. Although light output is least affected on fluorescent lamps, undervoltage makes them flicker, hard to start. Mercury lamps go out altogether at 10% undervoltage . . . require up to 20 minutes to regain full light output.



ALLIS-CHALMERS





A Big Help

on small—as well as big—deaeration jobs

Small deaerators are big business at Worthington! That's why the plant with small-capacity requirements will benefit by getting acquainted with the complete range of Worthington deaerating equipment.

Worthington Gives You All Types, All Sizes

Worthington deaerating heaters and deaerators are built in sizes to handle from a few thousand pounds an hour to over a million. They are tailor-made to fit the particular requirements of each job. Special designs are available for operation with scale-forming water.

Both tray and steam-jet types are made—with external surface-type vent condensers or internal direct-contact vent condensing. They can be furnished for any practical operating pressure—constant or variable—or for vacuum operation.

With a complete range of sizes and types at their fingertips, Worthington engineers can competently recommend the design best suited to *your* requirements.

Remember, too, Worthington designs are backed by over 50 years experience in the design and manufacture of direct contact feedwater heaters and over 100 years experience in hydraulic machinery.

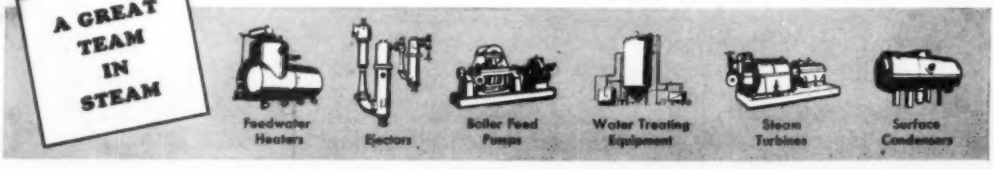
Send your water treating problem to Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, N. J.

WORTHINGTON

DEAERATORS

S.1.5

A GREAT TEAM IN STEAM



How to INCREASE BOILER RATINGS

with your present furnace and stack

Coppus-Dennis FANMIX Burners Give You More Heat with No Other Major Change in Equipment

Coppus-Dennis **FANMIX** Burners give you *perfect* mechanical mixing of fuel and air *at the burner outlet . . . instantaneous* ignition close to the burner . . . and *complete* combustion *without visible flame* when burning natural gas. No other burner combines these three advantages.

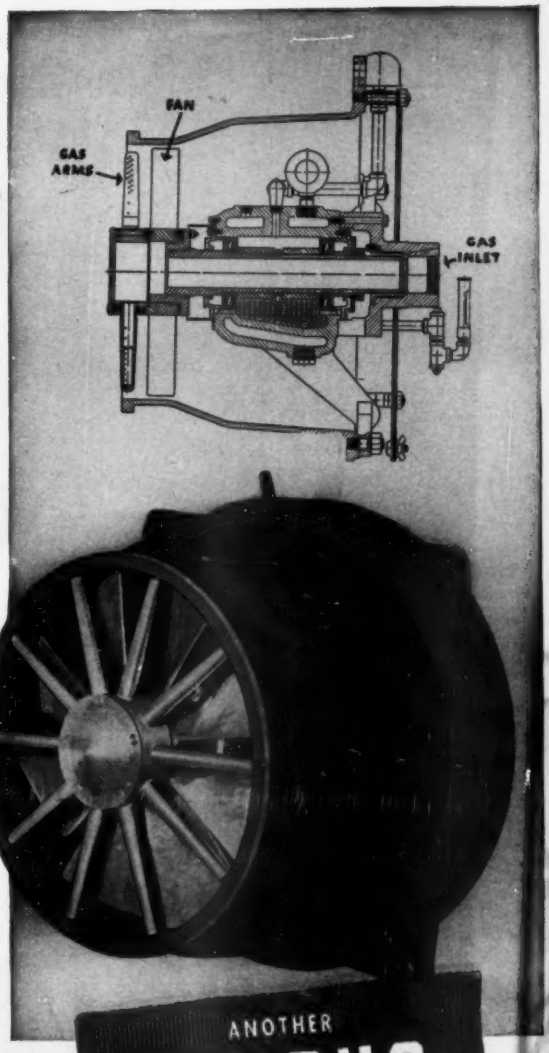
Because **FANMIX** delivers the *right* mixture of fuel and air *without blow-torch action*, all of your furnace space is used for combustion . . . *none for mixing*. That's why your present furnace can release more heat . . . why new installations can get more heat out of smaller furnace space.

Because **FANMIX** can be guaranteed to secure complete combustion of natural gas *with less than 5% excess air*, you get uniform "radiant heat" *without drifting hot spots*. That's why a FANMIX-fired furnace seldom varies in temperature more than 5% over its entire area.

WRITE FOR ALL THE FACTS

When you see in Bulletin 410-6 how fuel escaping from orifices in rotating driver arms rotates the fan to draw the correct proportion of air into the path of the fuel at right angles . . . how **FANMIX** creates its own forced draft, reduces stack requirements, prevents cracking of "wet" gas . . . how two FANMIX types handle either gas or oil or any combination of both — you'll understand why **FANMIX** Burners have such wide acceptance in oil refineries and power plants.

Send for the Coppus-Dennis **FANMIX** Bulletin 410-6. Coppus Engineering Corporation, Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, and REFINERY CATALOG.



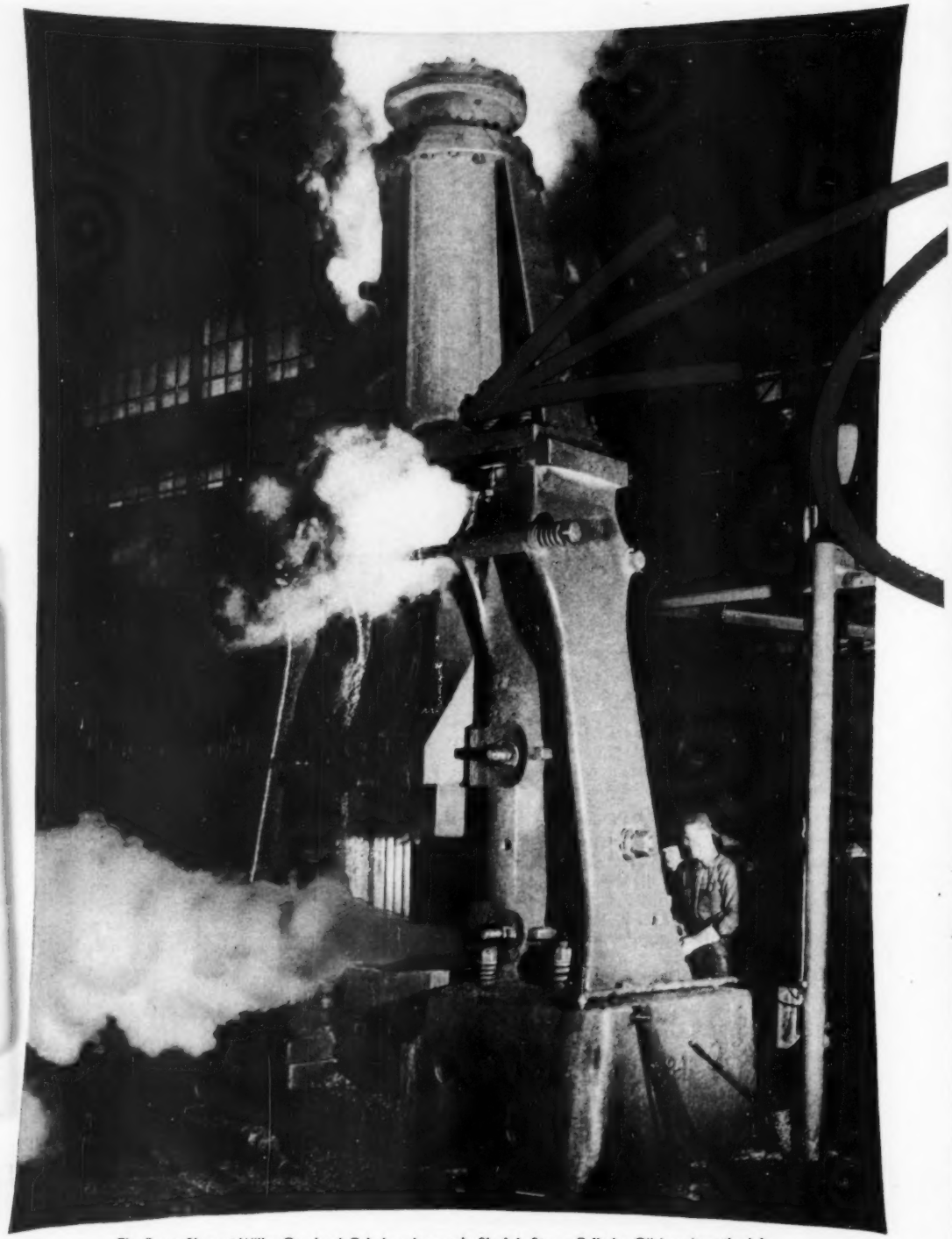
ANOTHER
COPPUS
"BLUE RIBBON" PRODUCT

COPPUS ENGINEERING CORP.
118 Park Ave., Worcester 2, Mass.
Please send Bulletin 410-6 to:

Name .....

Company .....

Address .....



The Forge Shop at Willys-Overland, Toledo, where only Sinclair Steam Cylinder Oil has done the job.

"NO OTHER OIL has done this Job!"

reports Willys-Overland Forge

Mr. Wm. Paris, Vice President in Charge of Manufacturing at Willys-Overland Motors, Inc. says, "We have saved plenty of cylinders, packing, and down-time since shifting to Sinclair lubrication."

Rising production forced the mammoth Forge Shop at Willys-Overland to step up ram speed 30%. As the power was insufficient, the steam had to be raised to 400°F. by superheating. Then the lubrication problem started!

The hotter steam and faster ram speed quickly burned up packings, and cylinders became scored. Many lubricants were tried. All failed to halt the destruction... until the Forge tried Sinclair Valve Oil Light. Now it reports it hardly ever has a scored cylinder and no more lubrication headaches. The Forge does not believe it possible to get finer steam cylinder lubrication and emphatically concludes that, "No other oil has done this job!"

If you have a steam cylinder lubrication problem it can pay you to consult with Sinclair, for Sinclair makes a wide variety of Steam Cylinder Oils to handle every possible need. Get in touch with your nearest Sinclair Representative or write Sinclair Refining Company, 600 Fifth Ave., New York 20, N. Y.

SINCLAIR STEAM CYLINDER OILS

for every steam cylinder installation

Controlled

the next Big step forward in AMERICAN POWER GENERATING PRACTICE

Within three decades the electric utility industry has reduced its average heat rate by 65 per cent – from about 40,000 Btu per kw-hr to about 14,000. And rates approximating 9000 are indicated for the most efficient stations now being designed.

On the steam generating side, this amazing progress is attributable to certain major advances of the period. These include . . .

- pulverized coal firing
- water-cooled furnaces
- preheated combustion air
- integrated boiler unit designs
- higher pressures
- higher temperatures
- improved firing equipment
- reheat
- improved methods and means of control

Combustion Engineering–Superheater, Inc., has been prominently identified with all these advances.

With this background Combustion offers the principle of controlled circulation as the next big step forward in power station practice. It does so with the confidence born of more than 10 years of development and operating experience. That this confidence is shared by leading utility engineers and their consultants is evidenced by the following contracts, placed since mid-1950, for . . .

eighteen C-E Controlled Circulation Boilers to serve an aggregate capacity of 2,500,000 kilowatts.

Company and Main Office	Station	Capacity per unit lb of steam per hr	Design Pressure	Steam Temp. primary-reheat
Cleveland Electric Illuminating Co., Cleveland, Ohio	East Lake	875,000	2030	1000 – 1000
Consumers Power Co., Jackson, Michigan	Weadock	1,050,000	2300	1050 – 1000
Duke Power Company, Charlotte, North Carolina	Buck	900,000	2010	1000 – 1000
Philadelphia Electric Company, Philadelphia, Penna.	Cromby	1,450,000	2075	1000 – 1000
Public Service Electric & Gas Co., Newark, New Jersey	Kearny	1,015,000	2650	1100 – 1050
Southern California Edison Co., Los Angeles, Calif.	Etiwanda	920,000	2100	1000 – 1000
Virginia Electric & Power Co., Richmond, Virginia	Chesterfield	750,000	1670	1000 – 1000
	Gilmerton	750,000	1670	1000 – 1000
Wisconsin Electric Power Co., Milwaukee, Wisconsin	Oak Creek	795,000	2050	1050 – 1000

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

ADVANTAGES

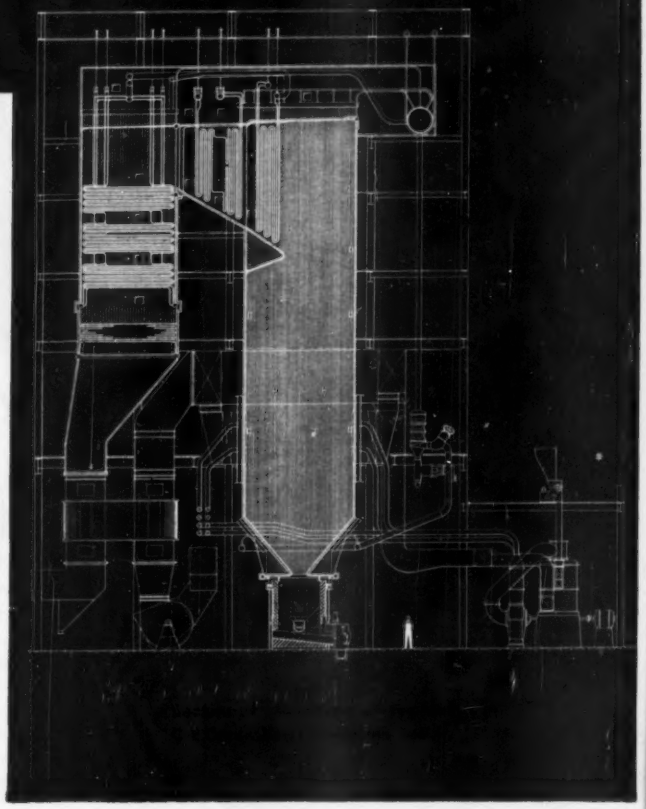
The major characteristics of the C-E Controlled Circulation Boiler are (1) the maintenance of positive, high velocity circulation in all circuits, under all operating conditions, (2) the proper proportioning of water supply to all heating circuits, and (3) the use of small-diameter, thin-wall tubes. These characteristics provide many design and operating advantages, the principal ones being:

DESIGN

- Permits the use of pressures considerably beyond the practical limits of natural circulation boilers
- Introduces new flexibility in proportioning of unit to fit existing space conditions or to reduce height and therefore cost of new plant structures
- Permits the use of bare furnace walls regardless of pressure
- Provides a substantial reduction in weight of pressure parts, and therefore of structural supports

OPERATION

- Maximum availability
- Faster pick-up or drop of load
- Reduced outage time for inspection or maintenance
- Higher plant safety factor



PREDICTION: The decade of the fifties will be marked by the ever increasing recognition of controlled circulation as a major advance in power station practice and by its wide adoption for the higher range of pressures.

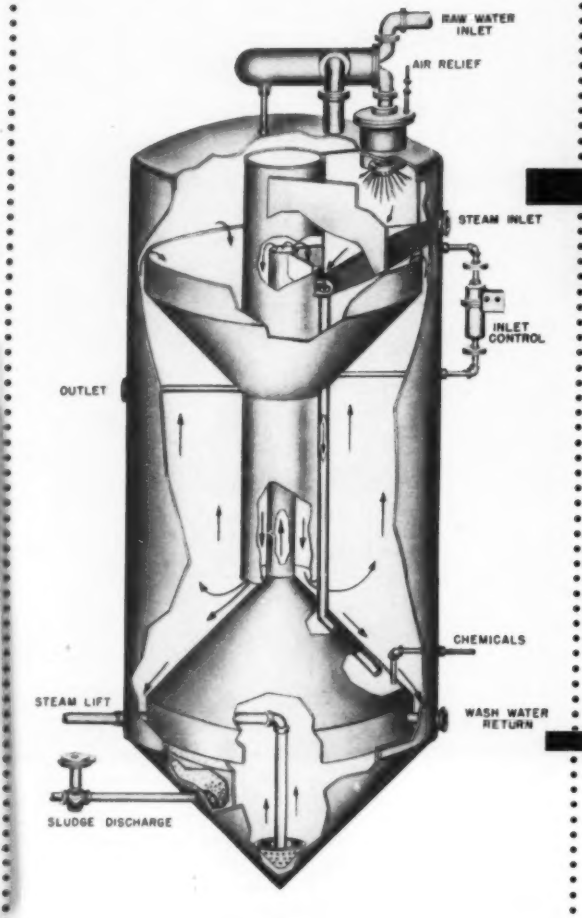
B-528

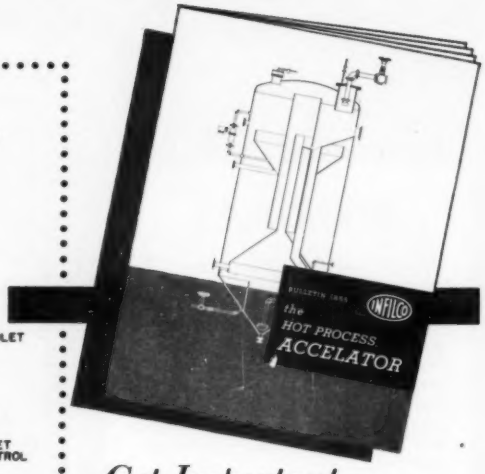
— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

Now Ready... bulletin 1855
hot process water treatment





Get Important New Facts on:

1 Chemistry of boiler feedwater treatment
2 Hot Process softening and deaeration
3 Advantages and limitations
4 Accessory equipment
5 Typical installations (including drawings)

SEND NOW FOR INFILCO BULLETIN 1855

Contains data based on 50 years' experience in softening and treating water.

HOT PROCESS

Accelator®

offers self-contained deaeration — controlled slurry recirculation — maximum silica reduction — chemical economy. Fully described in Bulletin 1855

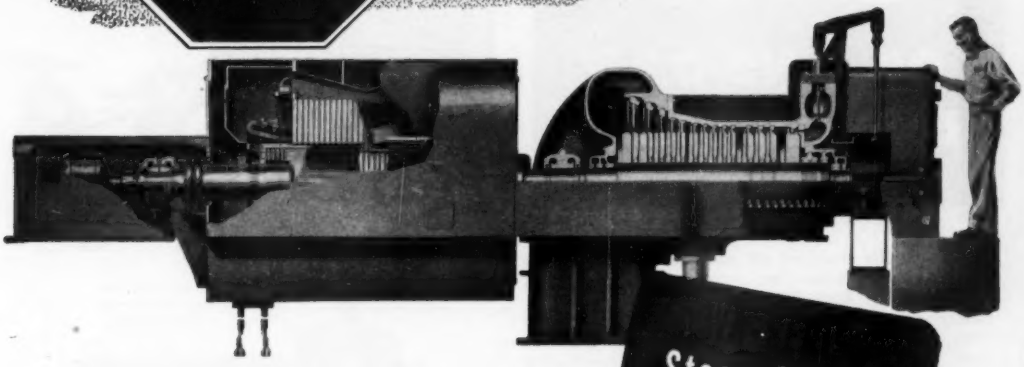
INFILCO
• BETTER WATER CONDITIONING • AND WASTE TREATMENT SINCE 1894

INFILCO INCORPORATED | *Tucson, Arizona*

FIELD ENGINEERING OFFICES IN 26 PRINCIPAL CITIES

World's Leading Manufacturers of Water Conditioning and Waste-Treating Equipment

END ..Generation Worries!



INSTALL MODERN EQUIPMENT

COMING DAYS of higher process steam and power demand will make power plant outages doubly hard to bear. Where will *you* be in this picture? Prepared with modern equipment to carry this severe load? Or just hoping for the best with outworn and outmoded equipment.

Truly modern WA-Series steam turbine generating units are already generating power and can be working for you sooner than you think. They are supplied in a wide range of NEMA ratings through 7500 kw, for either condensing or non-condensing service, with or without automatic extraction.

The accurate, reliable centrifugal type speed governor is the same kind used by Allis-Chalmers on its large steam and hydraulic turbines. The governing system incorporates oil pressure and if turbine system oil pressure should drop for any reason, the main throttle and inlet valves will close immediately, safeguarding the unit.

And just as in the larger Allis-Chalmers steam turbines ranging to 150,000 kw, trouble-free labyrinth steam seals are used for glands and interstage packing. Gland casings, moreover, are removable without disturbing the turbine casing.

These modern generating units are functionally attractive and completely coordinated in design. Impulse turbine, housing type air-cooled generator, and exciter are designed, manufactured, assembled, and tested under one supervision at one plant.

Get the *full* story on the quality features in the modern WA-Series! Be sure *your* next generating unit is up to date. Call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3530

BULLETIN NOW AVAILABLE!
Ask for WA-Series Bulletin 0387654

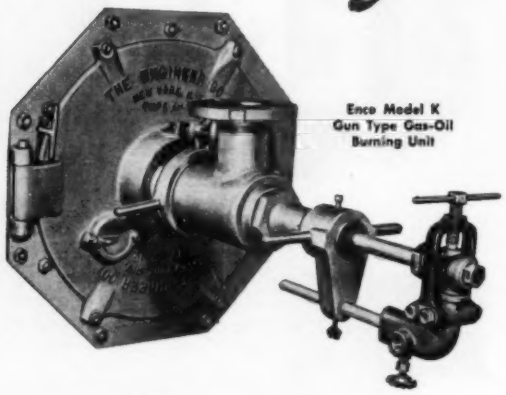
ALLIS-CHALMERS

TURBINES & GENERATORS | CONDENSERS & PUMPS | SWITCHGEAR & BREAKERS | MOTORS & CONTROL | TRANSFORMERS | WATER CONDITIONING

World's Widest Range of Power Plant Equipment

flexible... 3 ways

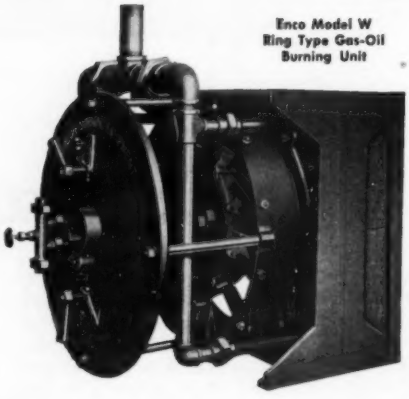
ENCO
OIL AND GAS BURNER UNITS



Enco Model K
Gun Type Gas-Oil
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.



Enco Model W
Ring Type Gas-Oil
Burning Unit

ENCO
INTERCHANGEABLE ATOMIZERS
FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.

Enco Standard Range Mechanical Atomizer Gun
Enco Wide Range Steam Atomizer Gun
Enco Wide Range Mechanical Atomizer Gun
Enco Standard Atomizer Gun Support
Enco Gas Burning Gun

EC-483

THE ENGINEER COMPANY 75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: R. A. BASKIN, LTD., 4339 MARVILLE ST., MONTREAL 34 P.Q.

measuring flow of water– steam– air–gas–oil–other fluids?

then use dependable HAGAN

RING BALANCE FLOW METERS

There are many reasons why you get dependable records from Hagan Ring Balance Flow Meters. These include utilization of the sound radial torque principle which is simple and reliable over a wide range; high torque-to-friction ratio; ease of dead weight calibration, and

- **No stuffing boxes**
- **High sensitivity at low flow rates**
- **Adjustable full scale range**
- **Mercury level not critical**

An economical feature of all Hagan Ring Balance Meters is that maintenance costs are low. For more information on how versatile Hagan Ring Balance Flow Meters will answer your metering problems, write to the Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

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Please send me further information on Hagan Ring Balance Meters.
I am particularly interested in .....

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NAME .....

POSITION .....

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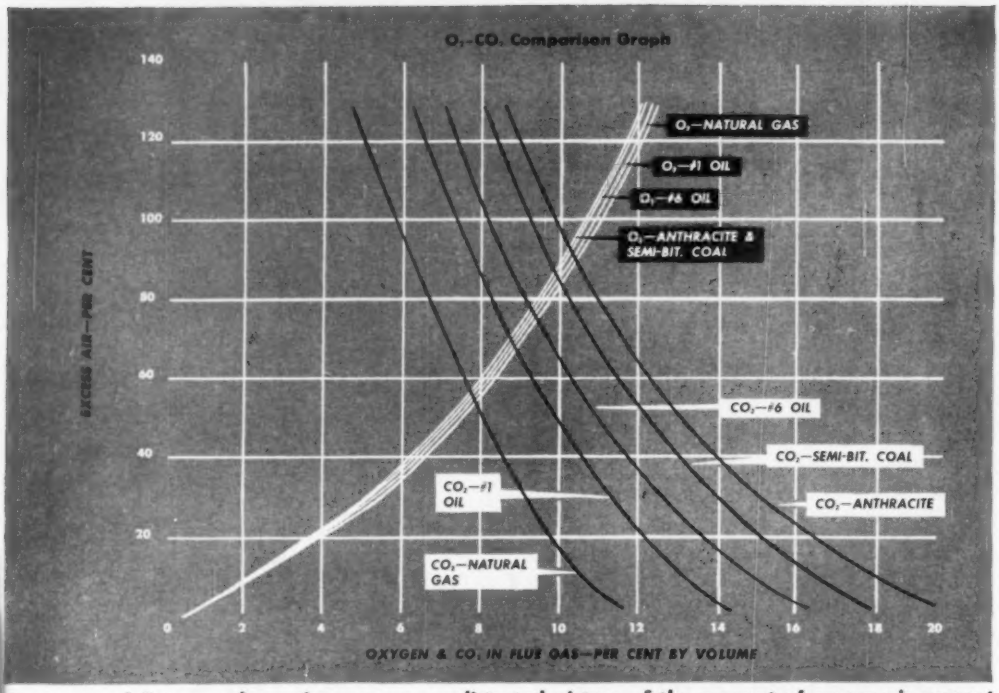
CITY ..... ZONE ..... STATE .....

How to burn Multiple Fuels efficiently



Oxygen and Oxygen alone gives you an undistorted picture of the amount of excess air present.

When switching from one fuel to another or burning more than one fuel at the same time, you can realize large savings with a continuous indication of Oxygen content in your flue gas—because Oxygen and Oxygen alone gives you an undistorted picture of the amount of excess air present.

This fact is borne out by the graph showing the relationship of excess air to CO_2 and O_2 in the flue gas of five common fuels. While the O_2 curves nearly coincide (especially in the important 30% excess air range) the CO_2 curves diverge widely.

Large Savings Possible

This deviation was costing a medium sized refinery in Michigan $35-40 per day in boiler room fuel costs. Burning a combination of oil and gas they found that a combustion control system to handle their multiple fuel firing conditions would cost more than their small boilers.

They purchased a Hays Magno-Therm Oxygen Recorder, and immediately found that their boiler operation was so inefficient that the pen would not stay on the 0-10% chart. However, by operating with reference to the O_2 recorder they were able to reduce fuel costs enough *to pay for the instrument in 40 days.*

With the Hays Magno-Therm Oxygen Recorder you get:

Continuous, highly accurate indication and recording.
Complete compensation for temperature and pressure effects.
Freedom from chemicals or hazardous fuel burning in the analyzing process.
Swift, sure electronic operation.

If you are facing the problem of multiple fuel combustion, you will want a detailed copy of this O_2-CO_2 Comparison Graph as well as Hays Bulletin 50-829—describing the Magno-Therm Oxygen Recorder. Write for this free information.

THE HAYS CORPORATION
MICHIGAN CITY 7 INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

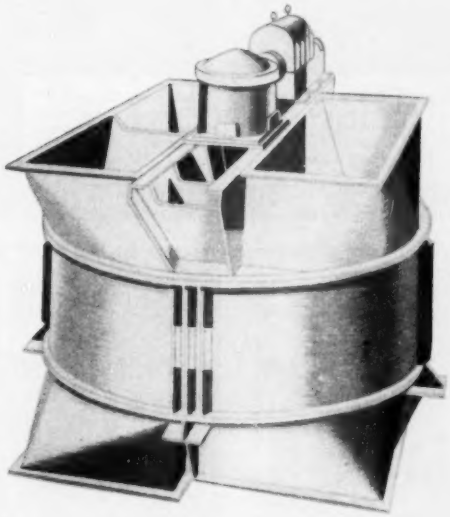
this preheater is cutting fuel costs in hundreds of plants!

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

The Ljungstrom air preheater has proved its value in industrial and utility plants throughout the country. That is why every year a constantly increasing percentage of the installed boiler capacity is equipped with Ljungstrom air preheaters.

Your fuel costs will be lower too, when your boiler is equipped with the Ljungstrom air preheater. The regenerative design of the Ljungstrom permits reliable operation at low exit gas temperatures. This assures the greatest possible heat recovery . . . reduces the amount of fuel required.

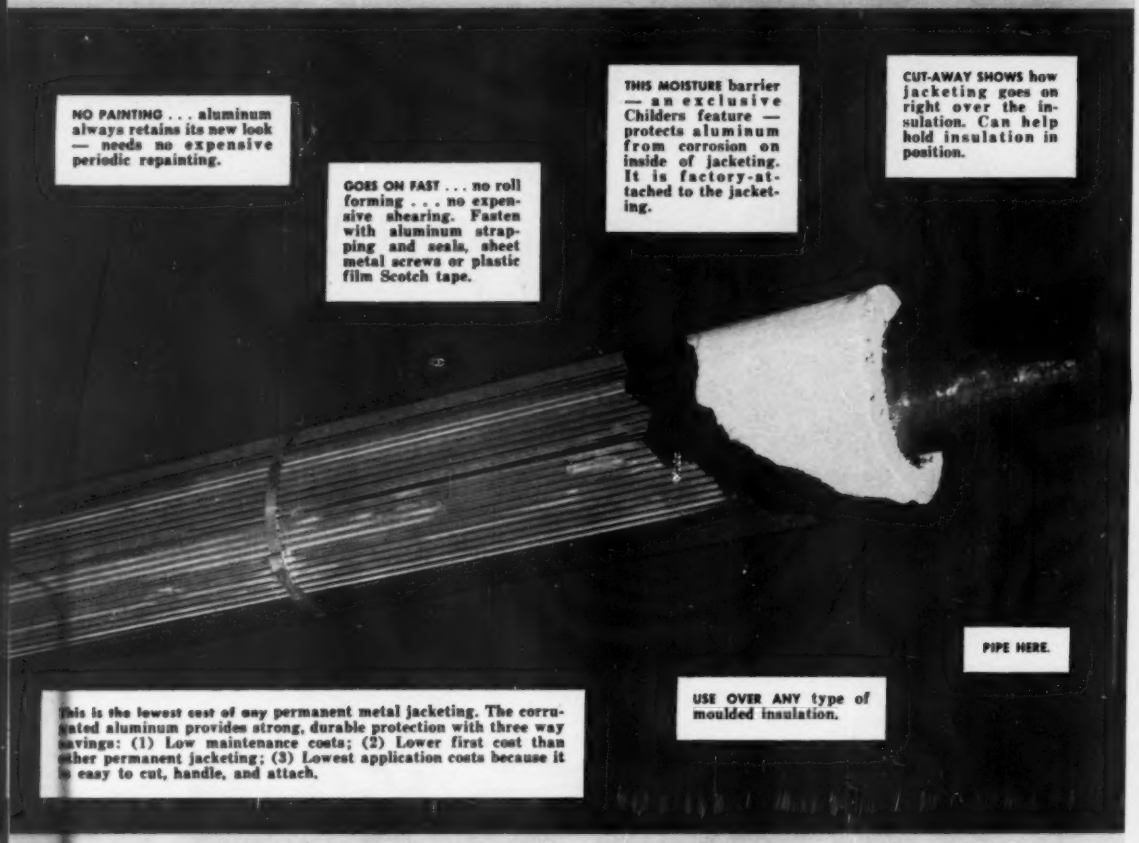
If you are planning a new installation, or expanding your present one, our engineers will welcome the opportunity to show you how the Ljungstrom air preheater can raise the overall efficiency of *your* plant.



THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

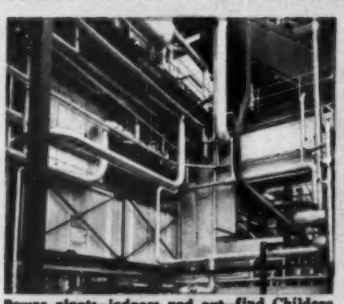
Save money—cut maintenance with


NO PAINTING . . . aluminum always retains its new look — needs no expensive periodic repainting.
GOES ON FAST . . . no roll forming . . . no expensive shearing. Fasten with aluminum strapping and seals, sheet metal screws or plastic film Scotch tape.
THIS MOISTURE barrier — an exclusive Childers feature — protects aluminum from corrosion on inside of jacketing. It is factory-attached to the jacketing.
CUT-AWAY SHOWS how jacketing goes on right over the insulation. Can help hold insulation in position.
PIPE HERE.
USE OVER ANY type of moulded insulation.

This is the lowest cost of any permanent metal jacketing. The corrugated aluminum provides strong, durable protection with three way savings: (1) Low maintenance costs; (2) Lower first cost than other permanent jacketing; (3) Lowest application costs because it is easy to cut, handle, and attach.

Childers Jacketing already in use in 567 of America's leading processing plants.

Oil refineries and gasoline plants had started to use sheet aluminum for protecting insulated lines even before Childers Jacketing was developed. They were tired of costly maintenance and repair with temporary materials. Now they are discovering that Childers Jacketing has even more advantages than expensive sheet aluminum—but costs less to buy and far less to apply.



Power plants—indoors and out—find Childers Jacketing their ideal material for protecting insulated lines as in this big Southern installation. Childers Jacketing is low in cost and easy to handle. More than that, it is a permanent-type weather protection that needs no painting. Its gleaming aluminum surface makes for "good housekeeping" in any utility or industrial power station.

Chemical and food plants such as this plant of the Minute Maid Corp. at Leesburg, Florida, like the low cost, low maintenance, and neat appearance of Childers jacketing. Indoors in food plants aluminum maintains that spotless look and can easily be washed. Outdoors in the tough corrosive atmosphere of most chemical plants the 3S alloy used for Childers Jacketing gives maximum life.

Childers Jacketing for insulated lines

Easy to apply—Childers Jacketing cuts man-hours

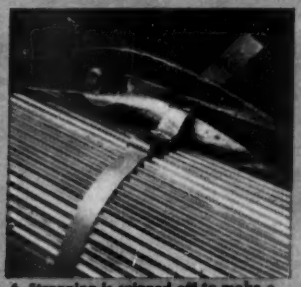
1. This is how easy it is to cut and handle Childers Jacketing right on the job. The four-foot-wide roll can be run out and cut to lengths by one man using a dull knife and a straight-edge. This cuts preparatory labor.

2. Best method of attaching jacketing is with aluminum strapping and seals. Here a seal is placed on end of strap, preparatory to putting it around the jacketing. This can all be done easily by hand; no tool or machine needed.

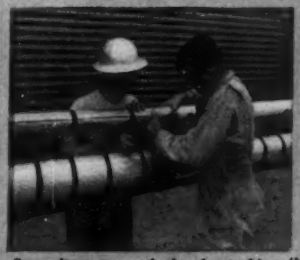
3. A two-man crew can apply the jacketing fastest. No special shop work or roll forming is necessary. Only tools are a pair of pliers and a wedge or screw driver as shown here. Note how easily the jacketing forms around the pipe.

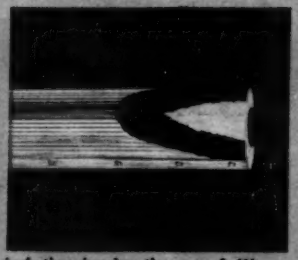
4. Aluminum strapping can be pulled plenty tight enough with just pliers like this. No special strapping tool needed. Wooden wedge is useful substitute for screw driver. Strapping is next pulled down between lugs.

5. Lugs are bent over easily, but hold strapping securely and permanently in position. If line is moved, lugs can be bent up to release strapping. Seals, strapping, and jacketing itself can be re-used in this case.



6. Strapping is snipped off to make a neat job, and the workman is ready to go on to the next strapping point. Minimum number of straps hold flexible Childers Jacketing firmly and snugly in place.





Two alternate methods of attaching the jacketing involve the use of (1) Minnesota Mining's No. 471 Plastic Film Scotch Tape; or (2) aluminum sheet metal screws. All methods are satisfactory; but aluminum strapping and seal method is probably best all-around.

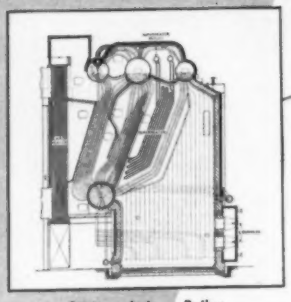
There are Childers Engineering representatives in every principal city. They are anxious to help you with your jacketing problem. Write for name of engineering representative nearest you. Address Childers Manufacturing Co., Dept. P5-2, 625 Yale St., Houston 7, Texas.

CHILDERS
ALUMINUM WEATHER-PROOF
Jacketing

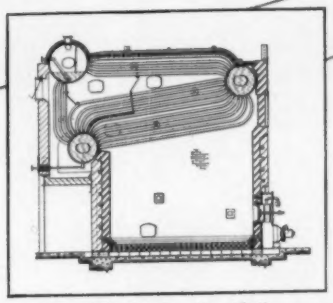
Under CMP regulations, Childers is a Class B product, the use of which is not restricted.

LOW-COST STEAM

is a "family" affair at B&W

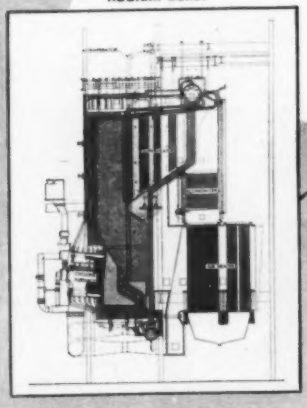


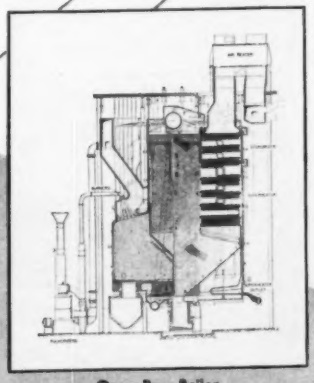
Stirling 4-drum Boiler.



Type H Stirling Low-Head Boiler.

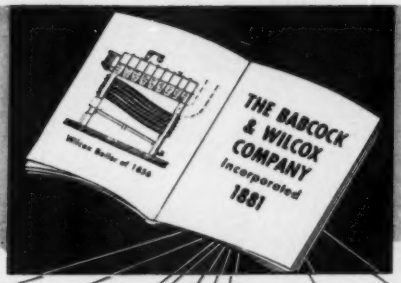
Radiant Boiler

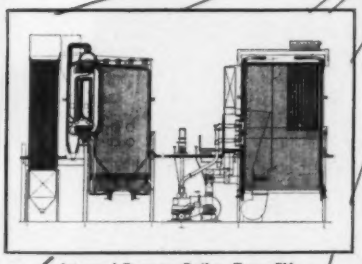




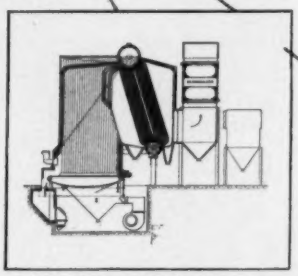
Open Pass Boiler.

BABCOCK & WILCOX

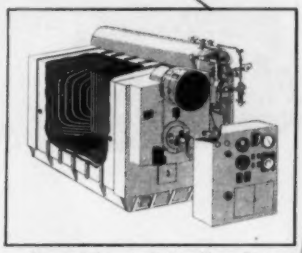




Integral-Furnace Boiler, Type FH.

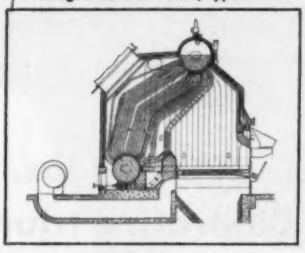


Integral-Furnace Boiler, Type FL.

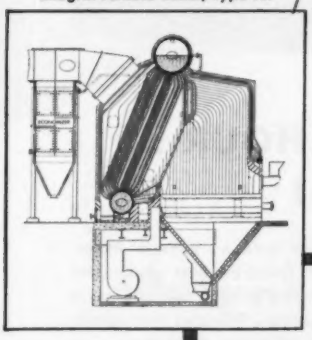


Integral-Furnace Boiler, Type FM.
(SHOP-ASSEMBLED)

Integral-Furnace Boiler, Type FF.



Integral-Furnace Boiler, Type FJ.

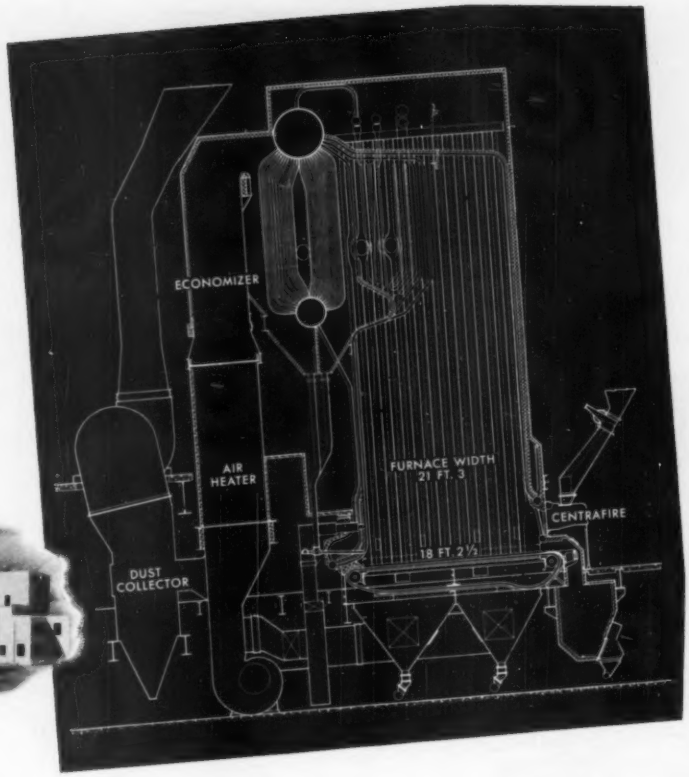


In the development of boiler designs, B&W's pioneering innovations during the last 70 years parallel and reflect an increasingly wide variety of user-requirements. Today, B&W offers an integrated "family" of service-tested boiler designs from which it is possible to select a steam-generating unit to satisfy virtually any requirements.

Shown here, for example, are current versions of some popular B&W boiler designs. Units of these types have been installed spanning a range of steam capacity from 2,800 to 1,370,000 lb. per hr.; final steam temperatures to 1050 F.; and boiler design pressures to 2650 psi.

In each of these types, standardization has been carried forward to the furthest possible degree commensurate with the necessarily diverse requirements of central station, industrial, and non-industrial operating practice. B&W Sales Engineering, established upon this broad base of design categories, is able to bring the most considerate and unbiased attention to your particular steam-generating problem—an approach essential to realizing the advantages inherent in whatever type of boiler is best suited to your operation. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

G-5497



Engineers for the Bay Front Steam Plant of the **Lake Superior District Power Company** at Ashland, Wisconsin, were **Sargent & Lundy**. The Westinghouse Centrafire with Traveling Grate will carry a constant load of 200,000 lbs. of steam per hour, with peaks of 230,000 lbs. of steam per hour.

CONSTANT LOAD 200,000 lbs. per HOUR... another Centrafire triumph!

The Westinghouse Centrafire® with Traveling Grate now being installed for the Lake Superior District Power Company is one of the largest Centrafire units that has been ordered to date. This utility and their consulting engineers wanted a stoker that could maintain a constant load of 200,000 lbs. of steam per hour... with peaks of 230,000 lbs. of steam per hour ... despite continuous feeding of wet and storage coal. Moreover, they needed a stoker that could absorb foreign objects in the coal, without interruption or damage to the apparatus.

The ability of the Centrafire to "take it" and continue without load loss under severe conditions has been demonstrated in factory tests and in power plant installations. Wet coal, storage coal, bricks, blocks of wood, insulators, cable, bolts and many other foreign objects have been deliberately introduced into the feeders with no adverse effect.

There are many other features that make the Centrafire outstanding . . . they're built into the basic design, not added as accessories. Whether your application calls for 50,000 lbs. of steam per hour . . . or 350,000 . . . the Centrafire with Traveling Grate offers advantages you should investigate. Call your nearby Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

J-50537

YOU CAN BE SURE...IF IT'S Westinghouse

STOKERS

Remember—

the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

It's a neat job... and it's stronger

● Welded piping systems are streamlined. They save space, are easier to insulate and are permanently leakproof.

For a complicated connection like this, use of the TUBE-TURN Welding Cross also means extra strength. This welding cross is made from the same seamless tubing and by the same process as TUBE-TURN Welding Tees. Bursting pressures obtained in tests of representative tees and crosses have averaged more than 25% higher than required by standard codes. This gives you extra quality at no extra cost.

Write Dept. C-12 for free booklet, "Allowable Working Pressures".

Welding your piping with TUBE-TURN Welding Fittings means a neater design and stronger construction. Get in touch with your nearby TUBE TURNS' Distributor. There's one in every principal city.

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO... A wholly owned subsidiary of TUBE TURNS, INC.

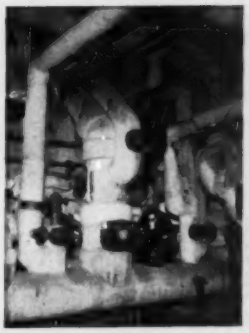
50 miles of *permanent piping* in world's tallest building

● In construction of the Empire State Building, designers wanted to eliminate piping maintenance.

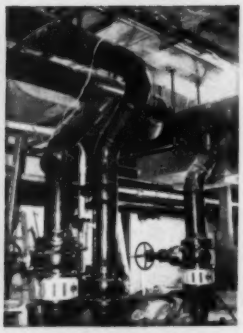
That's why a welded piping system, using TUBE-TURN Welding Fittings, was specified for all critical lines, employed for heating, refrigeration and other services. The original, and additional piping since added, continues to give leakproof permanence.

That's mighty important when you consider that the structure has 50 miles of piping, which last year delivered 72,000,000 pounds of steam, in addition to other services. Moreover, the system has conserved space, and provided optimum flow conditions.

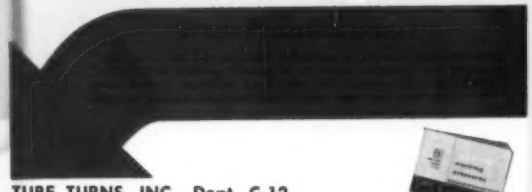
Workman applies finishing touches to insulation on new 12" chill water lines. Note ease of applying insulation on TUBE-TURN Welding Elbows. With no flanges to work around, piping can be much more compact.



Steam header fabricated with TUBE-TURN Welding Fittings feeds 8", 10", and 14" lines with steam at 150 psi. From central heating plant, steam flows to steam stations for distribution to different areas.



New water cooling plant will supply tenants with modern air conditioning facilities. Here, use of TUBE-TURN Welding Elbows and Welding Reducers simplifies piping to refrigeration machinery, and assures a leakproof system. Plant will eventually develop 3500 tons of refrigeration.



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224 East Broadway, Louisville 1, Kentucky

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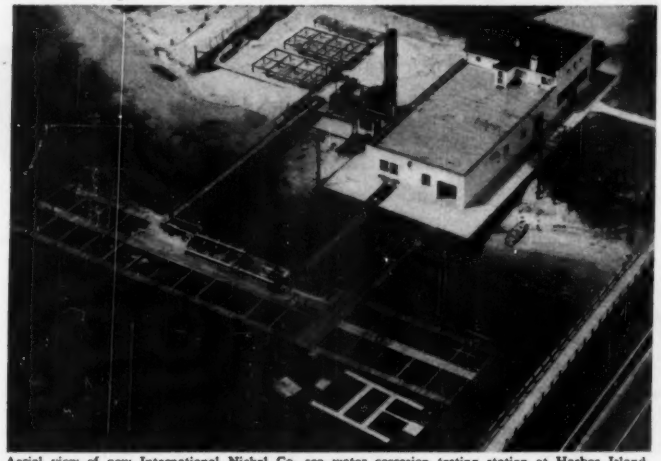
LOUISVILLE 1, KENTUCKY

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Aerial view of new International Nickel Co. sea water corrosion testing station at Harbor Island, Wrightsville, North Carolina.

Kure Beach Tests Help Lengthen Condenser Tube Life

Sea water corrosion testing of copper-base alloys continues to be an important phase of Bridgeport's Research Program. This work was originally started at the International Nickel Company's sea water corrosion test station at Kure Beach, North Carolina. It is now being carried on at Harbor Island, Wrightsville, North Carolina. During the past 8 years Bridgeport has tested thousands of metal samples.

Many test conditions closely approximate the "in-use" environments of condenser tubing installed in surface condensers operating with circulating sea water. Test samples are suspended in clean sea water flowing at a velocity of approximately two to three feet per second with a water temperature ranging from 35° to 85° F.

Test Procedure

Representative control samples were physically and chemically tested. Before assembly in special test racks, each sample was carefully annealed, cleaned, weighed and measured. The test racks were then submerged approximately 15 inches below the surface of the water.

At regular intervals (approximately 6 months) the test racks are removed for visual inspection and several are taken to the laboratory where they are dismantled for cleaning, weighing, inspecting, testing, and calculation of the rates of corrosion.

Results Found Helpful

Much valuable information was gained which has proved helpful in selecting copper-base alloys for sea water applications. We have been able to study impingement corrosion and the effects of alloy changes on pitting associated with impingement corrosion, and general surface pitting. We have also observed the extent and depth of corrosion based upon weight loss and loss in tensile strength, and the effect of metal hardness or temper on corrosion rate.

Since the results of the tests revealed those alloys with the greatest resistance to biofouling and corrosion in sea water, we have been able to improve them by modifying the amount of various alloying materials.

Improving Resistance To Impingement Corrosion

For example, one of the first things noted in connection with the test specimens was that the appearance of the leading edges varied considerably from one alloy to another. It was found that some of the specimens lost their sharp edges (see Fig. 1) and took on a rounded appearance. Those alloys which were most worn on the leading edge also had bright, clean leading edges without any visible corrosion film in this area. This led to a very marked decrease in the width of the specimens, and since the trailing edge of these specimens suffered very little change, the depth of corrosion on the leading edge could be measured directly with a micrometer.

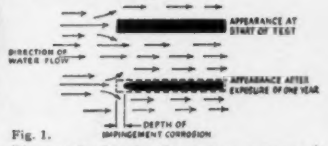

APPEARANCE AT START OF TEST
DIRECTION OF WATER FLOW
APPEARANCE AFTER EXPOSURE OF ONE YEAR
DEPTH OF IMPINGEMENT CORROSION

Fig. 1. Diagram showing the change in appearance of the leading edge of specimens due to impinging stream of sea water.

The final width of the specimen subtracted from the original width was called the depth of impingement corrosion. These measurements revealed that the following alloy changes led to marked increases in resistance to impingement corrosion:

(1) the combined addition of 5% aluminum and 0.25% arsenic to copper;

(2) the combined addition of 5% tin and 0.1% phosphorus to copper;

(3) the addition of approximately 0.5% iron to 70-30 cupro nickel;

(4) the addition of 2% aluminum and 0 02% arsenic to 75-25 copper-zinc alloy.

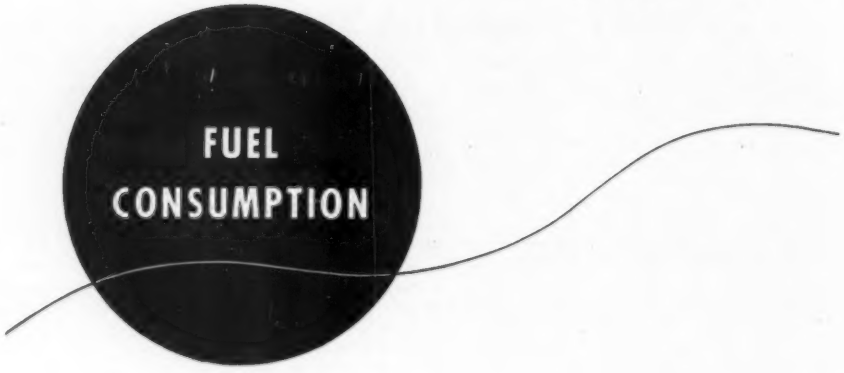
The addition of arsenic or tin to Muntz Metal increased the rate of impingement corrosion. It is evident that, while uniform dezincification is in progress (as in the 60-40 brass, Muntz Metal), no impingement corrosion occurs. This indicates that the dezincification reaction overpowers the impingement corrosion reaction.

Additional information is constantly being gleaned from sea water tests. This is considered in conjunction with the results of other research carried on by the Bridgeport Laboratory to assist in getting longer service life from condenser and heat exchanger tubing

(7583)

MAINTENANCE

Consider the figures



IS the low bid on a combustion control system the thrifty bid? What about maintenance? Depreciation? And fuel consumption?

Hagan Combustion Controls are ruggedly built, designed to keep maintenance costs at a minimum, will outlast the life of the boiler.

Fuel costs are far greater than maintenance or depreciation. A 100,000 lb/hr boiler, operating on a normal schedule, will consume about $7,000,000 worth of fuel during the life of the boiler. If your combustion control system wastes just 1% of the fuel, you would lose some $70,000—a figure that's not in the bid, and is considerably more than the difference in the initial cost between the simplest system available and an adequate Hagan Combustion Control System.

that aren't in the bid—

Therefore, the important item is not the initial cost of the combustion control equipment, but what that system does to your fuel costs. Hagan Combustion Controls give trouble-free service, and *accurately control fuel consumption for economy.*

DEPRECIATION

Our engineers will be glad to discuss your combustion control problems. Write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

HAGAN HALL BURDMIN CALGON

BOILER COMBUSTION CONTROL SYSTEMS
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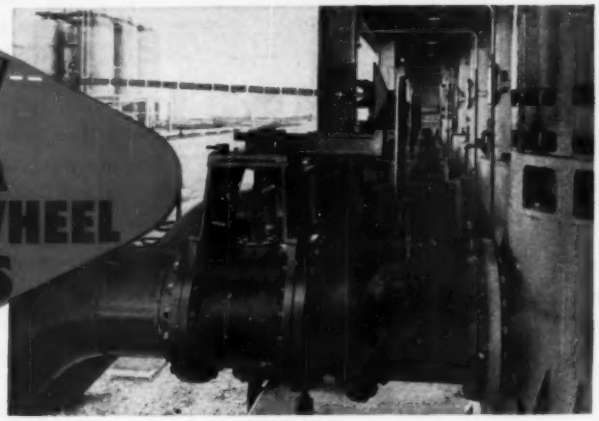
• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

SIX HANDWHEEL TURNS



. . . Operate these R-S Valves

This installation of twenty-inch valves in the water system to one of the large oil refineries in Louisiana is another example of R-S time-saving efficiency. Such ease of operation is an important consideration in any pumping operation and especially where a battery of synchronous driven pumps discharges into a common header. Burned-out motors at start-ups can be practically eliminated.

Substantial savings in pumping power result due to the low pressure drop. The beveled vane ordinarily seated at a 12½° angle means greater control rangeability either manual or automatic and no down-time for cleaning.

Install easily operated R-S Valves and obtain the most from your valve investment. Your local R-S representative is a valve expert—know him well.

R-S PRODUCTS CORPORATION

4600 Germantown Avenue, Philadelphia 44, Pa.

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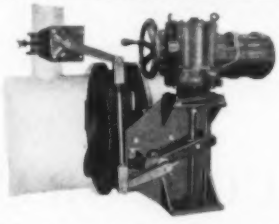
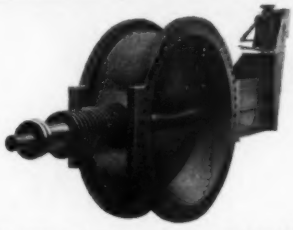


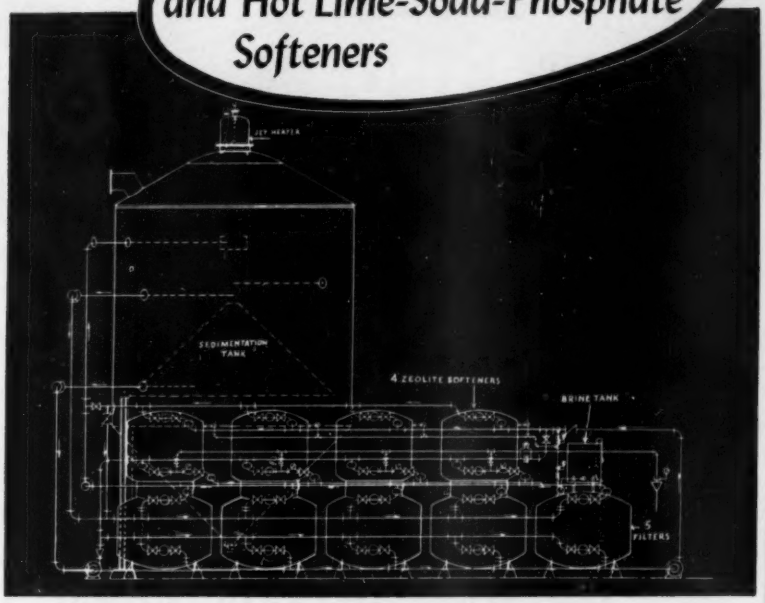
No. 798—Thirty-six inch and eight-inch R-S heavy duty valves of R-S "H" Metal at elevated temperatures for foundry cupola control. When the larger valve is wide open, the smaller valve is fully closed and vice versa. Slow operation is required, hence the motor operator with threaded reachrod.



No. 735—72-inch 125-pound "H" Metal R-S Valve for elevated temperatures. Valve is equipped with dual cooling fins. Oil cylinder and positioner utilizes 200 psig oil and 0-15 psig instrument air. Positioner cam driven simulating straight line semi-log control curve.

Cochrane HOT Lime ZEOLITE Water Softener

A Suggestion for Operators of Hot Lime-Soda and Hot Lime-Soda-Phosphate Softeners



The installation at the right shows a Cochrane Hot Lime-Zeolite Softener in a paper mill in the Northwest. The Zeolite Softeners are mounted on and supported by the filters in order to save space.

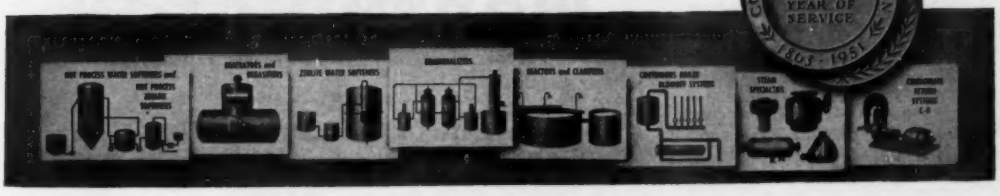
The introduction of Cochrane Hot Lime-Hot Zeolite Softeners presents an exceptional opportunity for increased capacity, with surprising savings in cost, to operators of conventional Hot Process Softeners who may be faced with expansion problems suddenly thrust upon them by today's production requirements. The conversion to Hot Lime-Hot Zeolite can be accomplished, in the case of Hot Lime-Soda Softeners by merely adding another settling tank to the existing settling tank, adding more filters, followed by a booster pump station discharging through a battery of Zeolite Softeners. In the case of two-stage softeners, the Hot Phosphate Tank is eliminated or may be used to double the first stage lime tank's capacity. More filters and a battery of Hot Zeolite units are added.

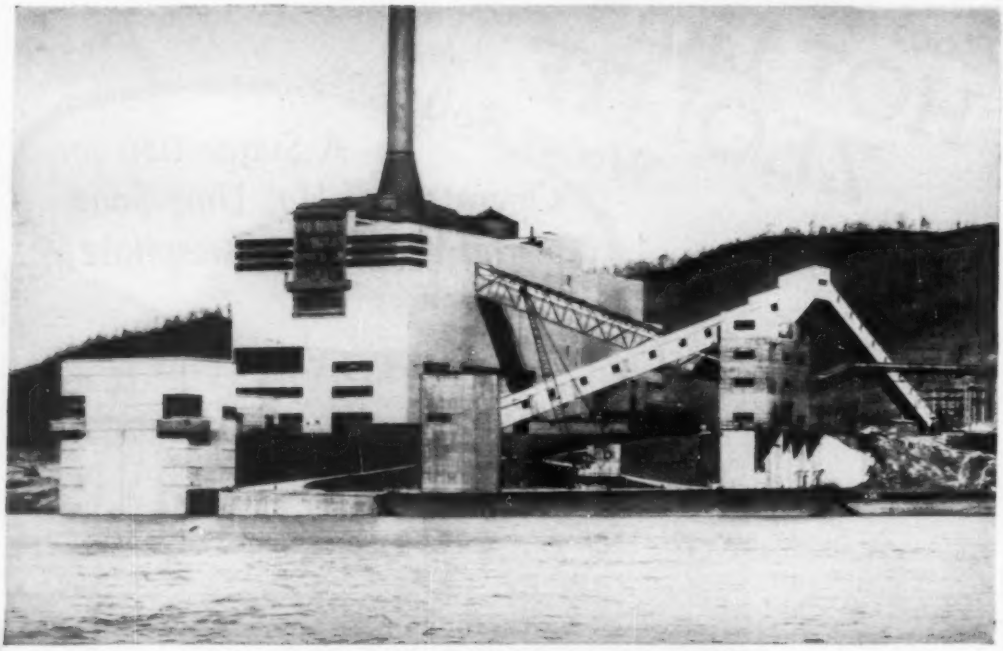
Cochrane Hot Lime-Zeolite Softeners are being installed in many expanding industries in all parts of the country.

COCHRANE CORPORATION • 3123 N. 17th St. • Philadelphia 32, Pa.

In Canada: Canadian General Electric Co., Ltd., Toronto • In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City • In Europe: Recuperation Thermique & Epuration, Paris

COCHRANE





Unique Circulating Water System Installed in This Power Plant

The R. E. Burger steam-electric plant of Ohio Edison Company is located on the Ohio River well above flood stage—which may reach as much as 60 feet above extreme low water. Water is supplied to the condensers by a patented circulating water system pioneered jointly by Worthington and the consulting engineer, Mr. George W. Saathoff.

All major equipment except circulating pumps, which are designed to operate completely submerged if necessary, are located above flood stage.

The new installation of a Worthington 70,000 sq ft two-pass condenser and auxiliaries, serving a 90,000 kw turbine-generator, is the third Worthington unit in this station. Two 46,000 sq ft condensers were previously installed.

For advice on any new installation or information on a wide range of power plant equipment, consult Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

HOW IT WORKS

Two full-capacity circulating pumps are used in series.* The primary pump, submerged below extreme low water, is a Worthington motor-driven HIFLO. Its high starting head characteristic is able to deliver enough water for starting purposes. A booster pump—a single-suction volute Worthington MIXFLO, mounted directly upon an hydraulic turbine—starts when there is enough water in the control well. The two pumps then operate automatically in series at full capacity.

Advantage is taken of maximum siphon effect from the condenser drop leg which enters the sealing or control well. From this well, all circulating water is passed through the hydraulic turbine. Thus the static head from sealing well to river level is utilized—75-80% being recovered—in reducing the work of the primary pump, with saving in overall pumping power.

The booster pump functions until rising water renders the turbine ineffective. Then the primary HIFLO works alone, producing full capacity under reduced head.

*In the new unit, there are two half-capacity primary pumps, permitting operation of only one in the winter when low water temperatures prevail.

Z.1.1

WORTHINGTON

WORLD'S BROADEST LINE OF STEAM POWER PLANT AUXILIARIES

Feed Water Heaters · Boiler Feed Pumps · Steam Turbines
Steam-Jet Ejectors · Water Treating Equipment · Surface Condensers

MECHANICALLY OPERATED VALVE Improves Performance

OF DIAMOND MODEL IK LONG RETRACTING SOOT BLOWER

The valve now being used on Diamond Model IK Long Retracting Blowers is actuated mechanically by the carriage that projects and retracts the lance tube . . . as shown by the photographs at the right. Opening and closing of the valve is positive . . . dependable . . . accurate.

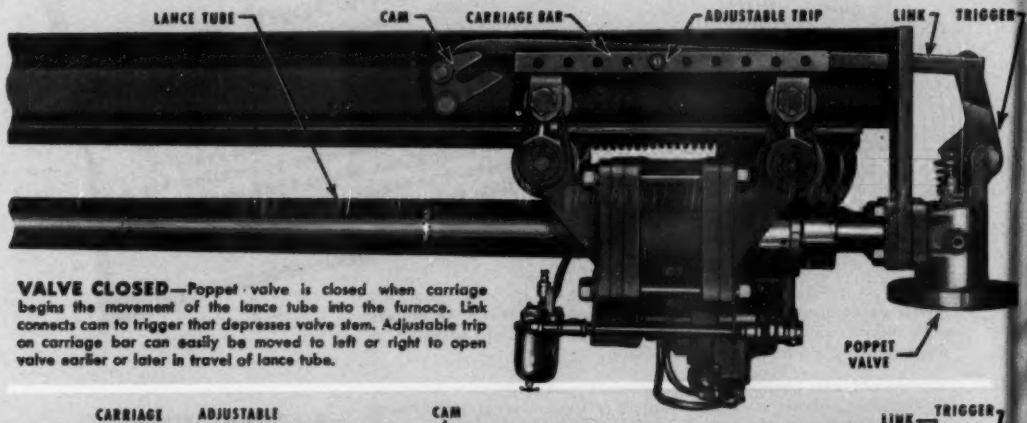
Note the simplicity of the mechanism. Ample adjustment is provided to permit valve operation to be set at the proper point for each individual blower. This valve has very low pressure drop and is suitable for either steam or air blowing; it has the exclusive Diamond adjustable pressure control unit for selection of blowing pressure to meet individual blower needs. This mechanically operated valve has been in field operation on many IK Blowers in severe central station service for the past two years. Results have been so satisfactory that it is now standard on IK Blowers.

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

ADVANTAGES

- *Positive valve action*
- *Simple and rugged mechanical linkage*
- *Adjustable valve operating position*
- *No critical adjustment for tight valve seating*
- *Completely adaptable to steam and air blowing, interchangeably*
- *Low pressure drop*
- *Adjustable pressure control on each individual blower*



VALVE CLOSED—Poppet valve is closed when carriage begins the movement of the lance tube into the furnace. Link connects cam to trigger that depresses valve stem. Adjustable trip on carriage bar can easily be moved to left or right to open valve earlier or later in travel of lance tube.

VALVE OPEN—Valve was opened when trip engaged cam and rotated it to position shown, thus moving link to left which caused trigger to depress valve stem and open valve. Valve remains latched open until carriage retracts lance tube and trip re-engages cam returning it to its original position.

Nalco

Route to Your Plant Process Engineers:

BOILER WATER (AND PROCESS) ANTIFOAMS

☆ **CLEAN STEAM** results when you use Nalco Antifoams . . . No carry-over . . . No scaling of traps or valves.

☆ **LESS BLOWDOWN** with Nalco Antifoams because much higher dissolved solids concentration can be safely carried.

☆ **PROCESS USES** of Nalco Antifoams are saving time, trouble, money in more and more plants . . . Do your Process Engineers a favor by passing this on to them—Nalco Antifoams react in much the same way in many process liquids as they do in boiler water!

Nalco Antifoams are the chemicals which can bring you this modern economy. They are fed directly into feedwater or boilers with other water treatment compounds, or independently, in dosages of *only 5 to 8 parts per million!*

The use of Nalco Antifoams has consistently enabled boiler operators to double, triple or even quadruple previous concentration limits . . . and at the same time produce cleaner steam.

Tests in an operating 70,000 lb./hr. boiler (see water analysis below), with 8 p.p.m. Nalco antifoam, failed to produce carryover when dissolved solids concentration *exceeded 25,000 p.p.m.!*

If your antifoam performance is less than you can get with Nalco Antifoams, act now to cut operating costs.

TEST BOILER WATER ANALYSIS at beginning of no-blowdown run, in p.p.m.: H-O, P-720, M.O.-750, Cl-900, SO_4-1420, PO_4-40, DS-3350, S.S.-Trace.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place
Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario.

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Serving Industry through Practical Applied Science

Helpful Bulletins

THE ANSWERS to many of your operating and maintenance problems are found in these new and recently revised catalogs and bulletins. List the paragraph numbers of those you want on the card below, detach and mail

ELECTRICAL

101 Explosion-Proof Motors — Eight-pp Form 1639, illustrated in full color, explains why company's totally enclosed and explosion-proof motors provide safe power and give long service, presenting types for both hazardous and non-hazardous locations. A large cutaway illustration shows construction details and there's a detailed discussion of the Lubriflush principle of bearing lubrication incorporated and the asbestos protection given motor windings. U. S. Electrical Motors, Inc.

102 Totally-Enclosed Motors — Advantages and limitations of manufacturer's totally-enclosed motors with air-to-water heat exchangers are related in Bulletin 05B7062. Properly fitted enclosures keep out dust, dirt, fumes and excess moisture, bulletin states, and maintenance is reduced and machine life lengthened. Describes three types of cooler arrangement — foundation, side or top mounting — built into the motors and explains how to estimate water requirements. Allis-Chalmers Mfg. Co.

103 A-C Motor Selection Tips — How to Select Alternating Current Motors for Applications [illegible], Heating, Ventilating and Refrigerating Equipment," is an 8-pp article outlining and illustrating basic types of a-c motors. Describes their starting and running characteristics, tells where and why each type is best suited for particular uses. Wagner Electric Corp.

104 Capacitor Publications — Illustrated booklets covering two types of capacitors, their features, application and operation, are offered. Bulletin GEC-908 on company's Tantalytic (electrolytic with tantalum electrode) capacitors designed for low voltage, d-c applications, includes photos, line diagrams and test data graphs. Bulletin GEC-809, 16 pp, is on fixed paper-dielectric capacitors and contains photos, line drawings and charts showing deratings for a-c and d-c applications. Ask for either or both bulletins. General Electric Co.

105 Synchronous Motors — Standard construction features of low speed, coupled-type, pedestal-bearing synchronous motors are described in Bulletin 05B7948, 6 pp. These features are available in motors with ratings of 100 hp and larger at speeds of 450 rpm or less. These motors are applicable for direct-coupled drives with widely varying torque requirements, such as in grinding mills, low-head centrifugal, axial flow, and screw-type pumps, ventilating and sintering fans. Allis-Chalmers Mfg. Co.

106 Mechanical Rectifiers — Bulletin 5109 offers 80 pp of information on mechanical rectifiers for low voltage power conversion, stressing advantages of these rectifiers. Of these, their high rectifying efficiency, small space requirement, design and operating features are discussed in detail. How rectifiers are constructed, how they work and equipment utilized are described and illustrated. Also discussed are contact mechanism, protection afforded, control and instrumentation. I-T-E Circuit Breaker Co.

107 Power-Conversion Units — Eight-pp Publication GEA-5656, on metallic rectifier power-conversion units, describes the application and operation of this equipment, and is illustrated with photos, line drawings and charts showing efficiency and regulation curves for the various-sized units. A specification guide for company's power supplies and exciters is also included, as well as complete rating charts and dimensions. General Electric Co.

108 Load Break Oil Switches — Bulletin DB61, 44 pp, contains detailed descriptions, dimensional data and price information on company's Type RA load break oil switches, which are 600-amp, rated from 600 to 22,000 v, used for sectionalizing and interconnecting primary feeders. Describes the "rocker arm" link which forms the essence of the RA switch, also other construction features. G & W Electric Specialty Co.

109 Motor Starters for Hazardous Spots — This 8-pp folder illustrates and describes company's Explo-Safe and Weatherproof motor controls for hazardous locations. Gives dimensions, weights, ratings and wiring diagrams for these magnetic across-the-line starters. The Arrow-Hart & Hegeman Electric Co.

110 Pressure Gauges — Bulletin 68, a 56 pp ordering catalog lists and illustrates three lines of pressure fittings: the Lock-Tite, featuring a complete range of case sizes; the Tite-Kind, which is precision engineered; and the precision Hi-Jen line which works on the accumulator principle. Listings cover connectors, lugs and taps for all kinds of copper conductors from #14 through 2,000,000 c mular mils. A picture table of contents is provided and full-page drawings show operation of each type. A special section is devoted to box tar fittings. Wire tables and charts included. The Thomas & Betts Co., Inc.

COMMUNICATIONS

111 Civil Defense Communications — Form GEA-125, 12 pp, pictures typical communications systems now in use which can be consolidated into a dependable emergency communications network in any community. Describes company's technical advisory service for civil defense radio communications and lists district representatives who are available to analyze existing systems and recommend ways of forging them into a single emergency network. Electronics Dept., General Electric Co.

112 Power Plant Intercom System — A communication system which is custom tailored to individual plant conditions and designed for two-way conversation over microphones and receivers is described in this 36-pp booklet. Text tells how system is easily installed and is adapted to different noise levels of a power plant. Photos show installations of paging equipment. Chi-Tronics, Inc.

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113 **Sound Systems** — Twenty-pp Catalog 5152 describes and illustrates sound equipment and accessories, giving specifications, suggested applications. Covers several types of amplifiers, recording equipment, intercommunication equipment, microphones and loudspeakers. Bell Sound Systems, Inc.

MATERIALS HANDLING

114 **Power Plant Coal Handling** — Book 2410, 44 pp., on coal and ash handling equipment, contains practical layout drawings as well as photos of actual installations. A book of ideas and suggestions for solving coal and ash handling problems of today's power plants, it pictures installations at both large and small public utility, industrial and public building power plants, including boiler houses modernized or improved after the original installation. Also discusses unloading of coal, auxiliary unloading, coal storage and reclaiming, crushers, transporting and distributing equipment. Link-Belt Co.

115 **MH Economy Primer** — "The How Book of Cost Cutting Materials Handling," 24 pp., is a revised edition of company's popular booklet published in 1947. Much of the "How Book" concerns basic background materials covering types of skids, pallets and other industrial handling tools. Also presented is a comprehensive plan for evaluating present handling methods through an engineering analysis similar to a time and motion study. The Yale & Towne Mfg. Co.

INSTRUMENTS AND CONTROLS

116 **Control from a Distance** — Eight-pp Bulletin 220-H4 describes company's Circumflo Telemeter for transmitting information and controls over a simple two-wire electrical circuit for unlimited distances. Explains operation of transmitter and receiver, illustrates mechanism and installations. Among applications described are measurement of flow of liquids and gases through venturi tubes, nozzles, orifices, flow over weirs, through Parshall flumes, proportional control, also pressure and temperature telemetering. Builders-Providence, Inc.

117 **pH and Conductivity Instruments** — Forty-pp Catalog 15-16, covering pH, oxidation-reduction potential, and electrolytic conductivity, contains up-to-date information on equipment for these process variables. Generously illustrated, booklet is extensive revision of a previous catalog and includes new information on recent designs of pH electrodes and conductivity cells. Includes fundamental operating principles, descriptions of measuring systems and details of components, also typical applications. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

118 **Liquid Level Gages** — Eight-pp Bulletin 176 describes and pictures remote reading liquid level gage, discussing their accuracy, other features. Operation of gages is explained, and several models described in detail. Installation photos, mounting diagrams, specifications included. Jerguson Gage & Valve Co.

119 **Easy Reading Gage** — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section OG. Pictures improved visibility, other advantages offered by this gage, explains principle of operation. The Reliance Gauge Column Co.

120 **Pyrometer Buyers' Guide** — Helpful technical data on the application and use of thermocouple pyrometric supplies is presented in 44-pp Catalog 100-4. Covers company's complete line, together with basic prices of standard thermocouple assemblies including base and noble metal elements of all gages, gives ordering procedure for various complete assemblies as well as extension wire, terminal heads and blocks, primary and secondary protecting tubes, insulated charts, wire. Exploded view of assemblies plus special molten metal, pencil type and midget thermocouples are included. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

121 **Heating, Air Conditioning Controls** — An informative ordering book for thermostats, motor-operated valves and accessories for heating, ventilating and air conditioning applications is offered in 48-pp Catalog F-753-3. Compiled to aid in the selection of control equipment to meet rigid specifications, book is well illustrated and provides application and installation data, dimensions, ratings. Includes an explanation of terminology and general engineering information on the use of control equipment. Barber-Colman Co.

122 **To Keep Track of Daylight** — Equipment for continuous recording of daylight intensity is described in Folder ND46-72. Illustrated with photos of recorder and illuminometer cell unit, tells operation and advantages of the equipment as a remote reporter to load dispatchers to whom up-to-the minute daylight data aids in anticipating sudden changes in lighting load. Leeds & Northrup Co.

123 **Water Columns** — Bulletin WG-1811, 20 pp, is a newly revised edition of company's booklet on water columns and gages. Among features described are improvements in the flat-glass inserts used in high-pressure gages. Fully illustrated, covers water column and try-cock details, construction details of water level gages. Includes column-gage arrangements, dimensions and prices, parts list. Fourteen installations pictured. Yarnall-Waring Co.

124 **Measuring System Variables** — Instrumentation Data Sheet 9.1-10 describes General Electric telemetering systems and their use with Brown Electrozik recorders in providing ample measurement of system variables plus wire speed transmission of intelligence to central locations. Describes telemetering requirements, fields of application, basic equipment, and operation of both frequency and balance type G. E. telemeters. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

WATER CONDITIONING

126 **Water Conditioning Equipment** — This bulletin gives a comprehensive picture of manufacturer's equipment, illustrating each type of unit and telling where it is best adapted for use. Covers monobed and four-column demineralizers, softener-dealkalizers, silica-removing demineralizers, deaerating heaters, degasifiers, filters and storage tanks. Performance figures on four typical demineralizing units are given. Permutit Mfg. Co., Inc.

127 **Care of Cooling Systems** — Bulletin 5015 discusses protection of engine cooling systems through proper water treatment, covering prevention of corrosion of diesel and other internal combustion engines. Explains necessity for water treatment, chromate control in closed systems, application of treatment and dosages as well as test methods in determining concentrations. Dearborn Chemical Co.

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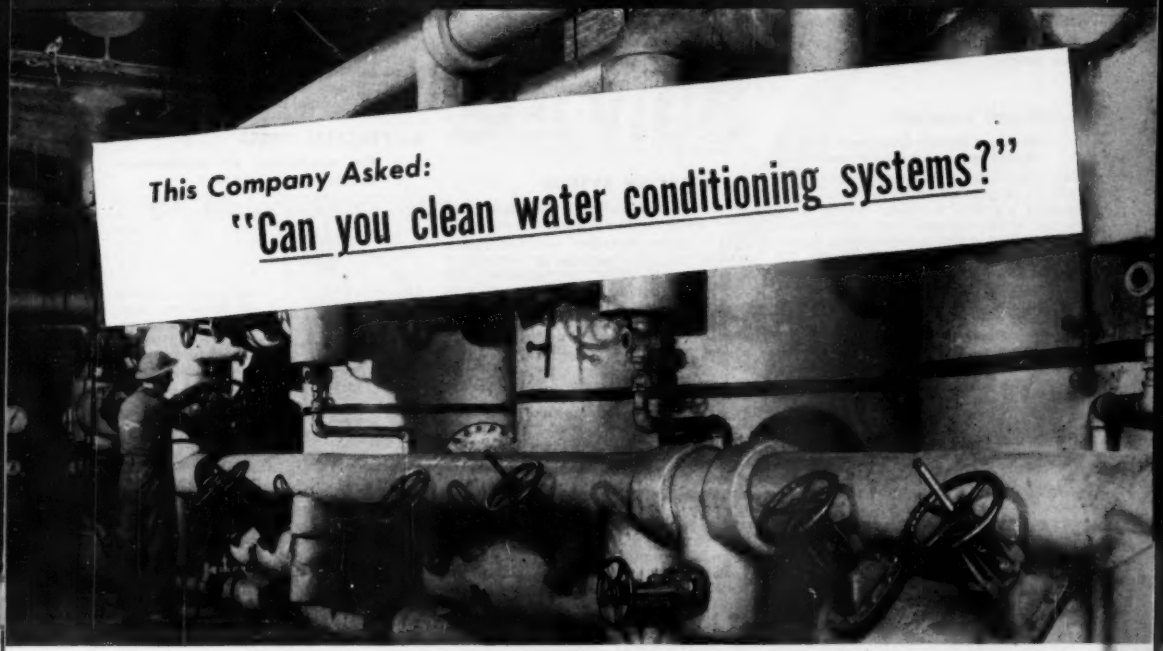
CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS



Dowell Service has cleaned many types of water supply equipment FAST!

If deposits are cutting production and profits in your plant . . . Dowell Service offers an effective remedy! For example, in water supply and water treating systems, deposits may accumulate in pipes, pumps and filters . . . impairing operating efficiency. Maintenance men in many industries rely on Dowell Service to clean operating equipment . . . *without dismantling and with a minimum of downtime!*

Experienced Dowell engineers do the job, using Dowell-designed, truck-mounted equipment. Liquid solvents designed to remove deposits quickly, efficiently and economically are applied according to the techniques demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing. Often equipment can be cleaned in operation.

Let Dowell Service *save you time and money* in your maintenance cleaning! Call the nearest Dowell office today for FREE consultation.

Recent Dowell jobs in Feedwater Systems

SCREEN FILTERS: In less than three hours, Dowell Service removed 90% of deposits from filters used to screen river water for a 48" strip mill.

WATER SOFTENER: Approximately 18 inches of hard calcium carbonate piled up in the bottom of a water softener's deaerating compartment. In less than one day, Dowell Service thoroughly cleaned compartment.

FILTER BEDS: The backwash rate on an anthracite filter was reduced to 75 gallons per minute by accumulated deposits. After Dowell Service, backwash rate was increased to an effective 385 gallons per minute.

ION EXCHANGE BEDS: Iron oxide clogged an ion exchange water softener. Before cleaning, two pumps were required to provide pressure for adequate back wash. After Dowell Service, one pump was sufficient.

FEEDWATER LINES: Before cleaning, it was necessary to use three 100 horsepower pumps to force water through clogged feedlines to a boiler house. Following Dowell Service, only one pump was required.

PUMP: Two high pressure feedwater pumps were nearly clogged with deposits. Dowell service completely cleaned them along with rest of the feedwater system.

WATER WELL: Before treatment, a water well produced only 108 gallons per minute with a 35' drawdown. After Dowell acidizing, water flow increased to 450 gallons per minute with a 27' drawdown.

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★ *Maintenance cleaning service for industrial heat exchange equipment.*
★ *Chemical services for oil, gas and water wells.*
★ *Magnesium anodes for corrosion control.*

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Equipment News

SUMMARIZED HERE are new products and improved ones . . . recent developments of leading manufacturers who will gladly supply further information at no cost. You may use the no-obligation, postage-paid card on pages 45 and 46 for your request. Just list the numbers of the items you'd like to know more about

1—PIPING HANGERS

Constant support type, have greater travel range and load capacity

The function of a constant-support hanger, to provide equal lift in all positions of travel of a piping system as it moves from expansion or contraction between its hot and cold positions, is said to be performed more perfectly by the improved Model L. Design improvements include provision for center support by placing equal dimensions on each side of the center supporting line, non-resonance in its springing system, and provision to give less horizontal shift of the load line as the load shifts. Maximum travel has been increased from 4 in. to 5 in. in the medium chassis, and from 8 in. to 10 in. in the large chassis.

Manufacturer points out that three chassis sizes now replace the four former ones, and the total load range, which formerly required 28 sizes, is now covered by 16 sizes. Discrepancies between calculated hanger loads and actual loads can be corrected at the time of installation by adjusting the position of one nut. Grinnell Co., Inc.

2—OIL FILTERS

For lubricating and fuel oil, feature interchangeable cartridges

The improved Hilco Hyflow Filters incorporate swingbolt head construction for quick opening of filter covers and a lifting device for handling the cover. These filters are available for use with factory-made throwaway cartridges, or the repackable type which operator repacks from bulk supply of filtering materials. The filtering materials are available for handling straight-run mineral oils, or the heavy-duty detergent type oils. Both types of cartridges are interchangeable. The filters come in capacities from ½ gpm to 1000 gpm, for fuel oil filtering, lubricating oil bypass, or full-flow filtering. Hilliard Corp.

3—INTERCOM SYSTEM

High and low level, designed especially for power plant installations

This readily installed communication system permits two-way conversations over close-speaking microphones and receivers which look like ordinary telephone handsets. It also permits paging over loudspeakers suited to the different noise levels of control rooms, turbine rooms, firing aisles. Gai-Tronics Corp.

4—ROTARY PUMPS

Heavy duty, sliding vane type, have built-in relief valve

All models of these new pumps are positive displacement type in which the pressure of the liquid being pumped maintains contact of the vanes against the liner. They are made in both internal and external bearing design, the external bearing models being especially suited for non-lubricating liquids such as gasoline and kerosene. Either standard fitted, bronze fitted or all bronze construction is available. Worthington Pump and Machinery Corp.

5—ELECTRICAL CONDUIT

Plastic armored metallic tubing for use in corrosive atmospheres

Designed for use where corrosive atmospheres necessitate frequent replacement of electrical conduit, this new Dekoron Conduit is made by an extrusion process in which a 0.020-in. coating of tough, corrosion-resistant vinyl or polyethylene plastic is extruded over standard galvanized electrical metallic tubing. By varying the thickness and composition of the plastic armor, the conduit can be given any desired electrical properties, manufacturer says, and adds that this conduit is impervious to corrosive effects of moisture, salt air, acids, alkalies, oils and grease and is immune to normal temperature changes. Installation of this conduit requires no special tools. Standard compression type couplings and connectors wrapped with electrical insulating tape are used at joints. Black is standard; other colors supplied. Samuel Moore & Co.

6—PEDESTAL PRESS

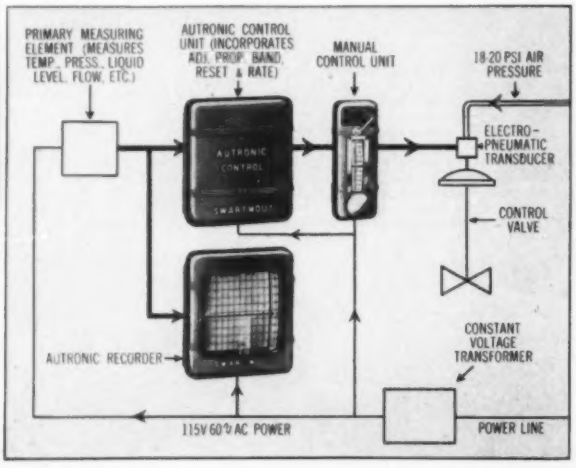
For production or maintenance pulling or installing jobs

A press designed especially for use with the Power-Twin 17½ ton ram which can perform 95 per cent of the customary pulling or installing jobs. Mounting a strong, practical, open-throat press plate it provides almost unlimited vertical adjustment and can be used for pulling wheels, pulleys, bushings, couplings, gears, shafts and bearings. The press is portable and compact, the base being only 20 by 21 in. The machine may be temporarily or permanently installed in convenient places near permanent equipment. The Model OTC-102 includes pedestal and press frame; accessories are available for practically any job. Owatonna Tool Co.

7—DEHYDRATOR

For removing free or entrained moisture from diesel fuel

Increased combustion efficiency, reduced carbon formation and less corrosion of working parts are claimed for internal combustion engines when using fuel dehydrated by this new unit. Dehydration is accomplished by passing the fuel through elements of wound cellulose cylinders treated coalescing media, perforated metal and glass cloth. Company points out that there are no moving



8—CONTROL SYSTEM

Automatic, electronic; for industrial power plants and central stations

Manufacturer of the Autronic Control System calls it the first centralized-control miniature, all-electronic system for measuring and controlling process variables, such as temperature, pressure, level and flow. The system consists essentially of a primary sensing element, Autronic control unit, and final control unit; it is powered by a 115 v, 60 cycle alternating current.

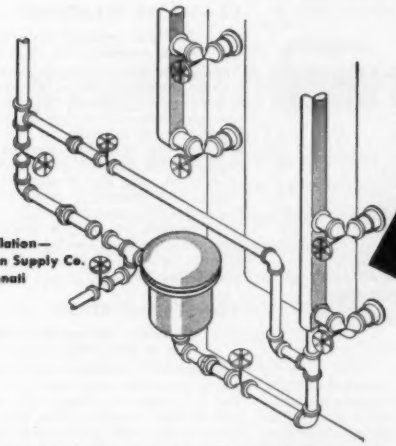
The primary sensing element generates a voltage directly proportional to any change in the process variable and this voltage is transmitted to the Autronic control where it is continuously modulated by electronic means. The Autronic control unit then transmits the resulting direct current to the final control element which may be electrically or pneumatically operated. Since the transmission of information throughout the system is by electrical means only, there is said to be no transmission lag and no booster mechanisms are required to overcome distance effects.

The compact plug-in type Autronic control unit can be mounted where convenient. It can be furnished with or without set-point adjustment and scale. The Swartwout Co.

for outstanding service

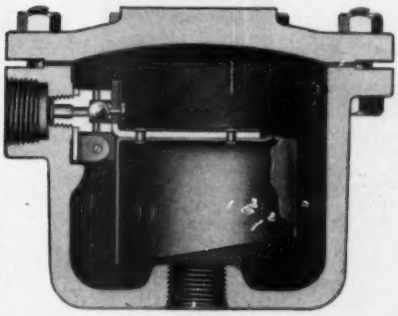
on Heavy-Duty Steam Drying Units

...for example



The installation—
American Linen Supply Co.
Cincinnati

Rely on Dependable CRANE STEAM TRAPS



Crane Inverted Open Float Steam Trap with patented ball-type disc, for 1 to 300 pounds saturated steam working pressures. Literature on request from your Crane Branch or Crane Wholesaler.

PROBLEM: To equip a steam-heated tumbler-type drier with a trap that would reduce start-up time to a minimum, and provide, automatically, a smooth, steady flow of hot, dry steam to the unit, with the lowest possible maintenance cost.

WORKING CONDITIONS: Steam pressure to drier, 125 pounds. Drier operated 16 hours daily on continuous batch basis.

SOLUTION TO PROBLEM: Crane No. 981, ¾-inch, 150-Pound Inverted Open Float Trap, carefully selected for adequate drainage capacity, and properly installed. (Now listed as No. 9810, with patented improved ball-type disc.)

RESULTS: Never requiring any repairs or new parts in more than 8 years' service, this Crane trap has given complete satisfaction. Periodic routine inspection only is total maintenance cost.

...ANOTHER TYPICAL CASE HISTORY demonstrating the better performance... the lower ultimate cost of Crane Valves of all types... and why—
More Crane Valves are used than any other make!

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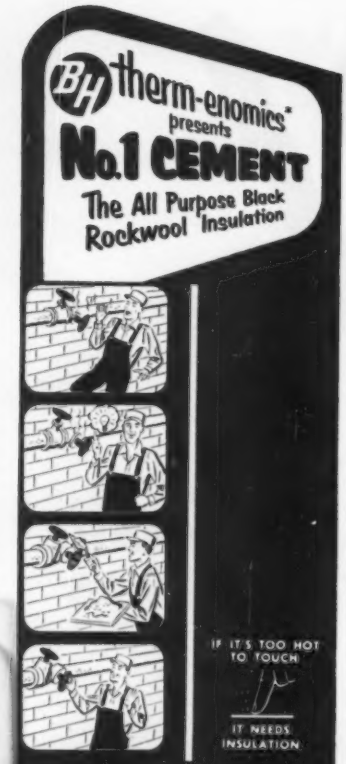
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IT NEEDS INSULATION

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Let B-H help you reduce heat loss . . . by recommending the type of insulation best suited to *your* problems of heat control. A *complete* line of *Black* Rockwool materials—cements, blanket, block, etc.—is the basis for Baldwin-Hill's THERM-ENOMICS* SERVICE.

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- ☐ No. 1 Cement —plastic insulation, to 1800°F
- ☐ Powerhouse Cement —high-adhesion finishing to 1700°F

BALDWIN-HILL CO.
904 BREUNIG AVENUE, TRENTON, N. J.

parts and with reasonable care the dehydrating elements will function indefinitely. Dehydrator is available in capacities of 350 and 600 gpm, with maximum working pressure of 125 psi. Shell and cover are heavy gage steel. Where there is a possibility of large volumes of water in fuel, a hydraulically balanced, automatic ejector is available as an accessory. Bowser, Inc.

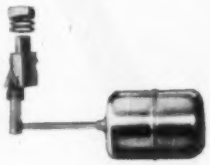
9—FLOAT VALVE

Offers compactness with large capacity, has wide application

The Series 18 is a float-operated valve, termed by its manufacturer as the simplest answer for hundreds of liquid level control jobs. It combines rugged, noncorrosive construction with simplicity of design and operation. Three variations of the series adapt it for a wide variety of operating conditions.

The No. 18 consists of valve mechanism and float. The Model 118, intended for protection against back siphonage, has the float mounted at right angles to the valve so the valve proper is always far above the water lever. The No. 518 includes the float and valve in a die-cast chamber with a cover, and is designed for external applications.

No. 18



No. 118

The valve mechanism consists of only a few parts and, except for the neoprene valve seat, all parts are copper or brass. The valve opens to full capacity with only small float drop and closes tightly against pressures to 100 lb. The entire assembly is held together by a single brass pin.

The Series 18 can be used on humidifiers, on evaporative coolers in air conditioning equipment; on wet and dry bulb hygrometers; also to add water to radiators of stationary engines. Capacities range to almost 5000 gal per hour, depending on supply pressure. McDonnell & Miller, Inc.

10—DUST COLLECTOR

For exhaust of fume-laden air, operates on 25-cycle power

The new Model 20ND30 Dustkop, designed for out-of-doors exhaust of air already cleaned of industrial dust but still containing toxic fumes, is a standard unit with motor for operation on 220 or 440 v, three phase, 25-cycle power. This collector is suggested for almost any type of industrial dust. Its capacity is reported to be 2450 cfm on a single 6 in. inlet with a 4.5 in. static suction. The size of the outlet for discharge of cleaned air to atmosphere is 8 in. The unit is 78 in. high, requires 22 by 40 in. of floor space. Aget-Detroit Co.

11—CONDENSATE UNITS

Single and duplex units, return condensate back to boiler

Designed to save fuel by returning condensate from steam coils, radiators and steam operated equipment, these new units are equipped with company's Motor Mount centrifugal pumps mounted on the legs of the tank. The motor has standard NEMA Type C mounting flange and is furnished for single-, two- or three-phase or direct current.

Duplex units in the line are for conditions involving occasional demands above the capacity of a single unit, or where a standby pump is desired to assure continuous operation. These units have two pumps, two motors, a storage tank, alternator switch and water level gage. Single units include one pump, motor, storage tank, float switch, water level gage and suction piping. The Deming Co.

12—WATER TREATMENT

Catalytic process for eliminating scale, reducing rust, corrosion

Applications for this catalytic process include the treatment of both industrial and potable water and the reduction of rust and corrosion in boilers, tanks, all types of water systems, air conditioning and cooling systems, gas and diesel engines. The catalytic action involved is said to stop the formation of new scales and gradually remove existing scale. Results are achieved by the catalytic process creating a dispersion of the elements in the water that have an affinity for forming scale and corrosion. Sola Catalytic Co.

13—STAFF STATION

Combines across-the-room reply and freedom from eavesdropping

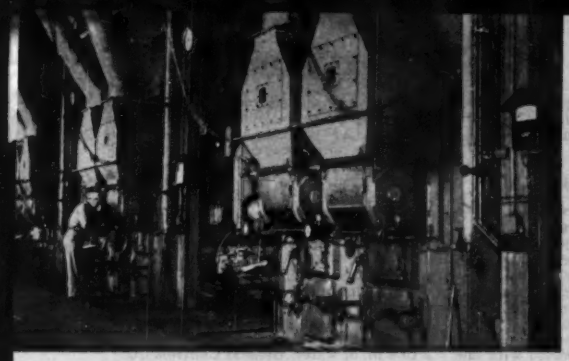
Through the development of an intercommunication staff station incorporating a "privacy" lamp, this manufacturer offers a staff station that lets the user answer calls from across the room while enjoying protection from eavesdropping. Company says the user of this staff station can be at the far side of the room, even 30 ft away, and hear and reply to all incoming calls without stopping his work to operate the station manually. At the same time he is protected against eavesdropping, because the instant a master station opens the line to call the staff station, a red lamp on the staff station lights up — notifying the user that the line is open. Finished in metalustre bronze. Executone, Inc.

14—HANDWHEEL

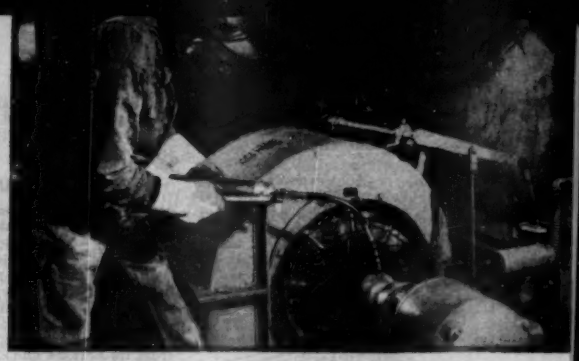
Adapted for small chainwheel operation, offers extra torque

The problem of closing small valves tightly, especially when they're 10 to 50 ft above the floor, is said to be solved by the Impactor Handle, designed to deliver more than twice the force of many handwheels. The lugs on the underside of this handle strike simultaneous blows against the lugs of an adaptor attached to the valve stem. These blows prevent stem twist and distortion which would result if the adaptor lugs were struck independently, company points out.

The Impactor Handle is available with two adaptors of square opening to fit most standard size stems of small valve makes. Sizes of the openings, which taper towards the top, are $^{13}/_{16}$ and $^{15}/_{16}$ in. with total taper equal to $^{3}/_{4}$ in. per foot. Edward Valves, Inc.



TO GENERATE STEAM for manufacturing, Triangle Conduit and Cable uses three 350 hp boilers. Each unit generates 22,500 pounds per hour, 24 hours a day, 5 days a week. *Sun Solaus Oil* lubricates the spreader stoker oil bath, *Sun 844 Grease* the pulley drive, stoker motor and pillow block.



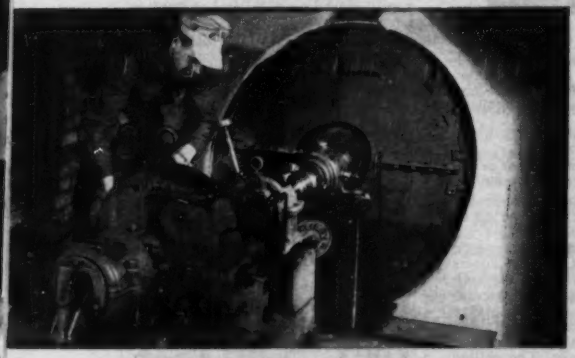
TO CONTROL THE AMOUNT OF AIR entering the fire box, three forced draft fans are kept in constant operation. The motor and fan bearings and the speed reducer motor are lubricated with *Sun 844 Grease*, while the gears and reducers are protected by a *Sun* gear oil.

MODERN POWERHOUSE ENTIRELY SUN-LUBRICATED

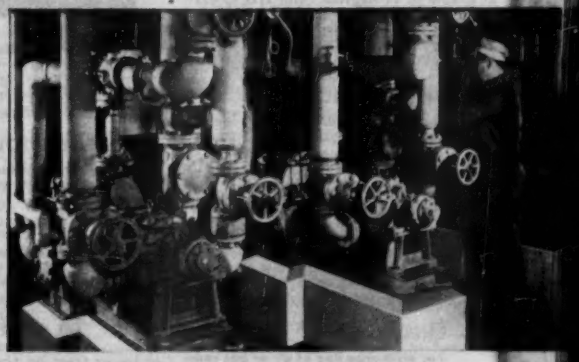
Triangle Conduit and Cable produces flexible and rigid electrical conduit and cable. Its modern powerhouse generates steam for galvanizing pipe and for heating the factory, the pickling vats and the enamel paint vats prior to dipping the pipes. From the very beginning of operations more than two years ago, Sun oils and greases have been used exclusively in all the equipment, and there hasn't been a single failure because of faulty lubrication.

This modern powerhouse is wholly lubricated by Sun "Job Proved" products and the factory partly so. In both, Sun's engineering know-how has effected purchasing and inventory economies through multiple use of a minimum number of oils and greases.

For technical assistance or a copy of the manual "Lubrication of Industrial Machinery," write on your business letterhead to Department PN-9.



TO HELP GET PROPER COMBUSTION in the boilers, three exhaust fans are used. The turbine which drives them turns up 3,600 rpm. The engineer says the lubricant, *Sunvis 951*, looks like new when it is changed to get rid of condensate.



TO FEED WATER TO THE BOILERS, two 3,500 rpm turbine-driven pumps are employed. A motor-driven pump is used in starting up when there is no steam pressure. *Sunvis 951* lubricates the turbines, *Sun 844 Grease* the pump fittings.

SUN INDUSTRIAL PRODUCTS

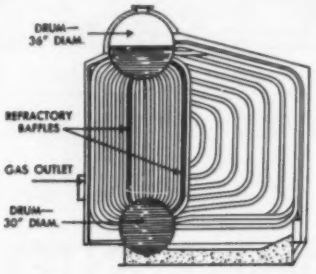
SUN OIL COMPANY, PHILADELPHIA 3, PA. • SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

SUNOCO

15—PACKAGED BOILERS

Moderate or higher capacity models, burn either oil or gas

Packaged units in company's new Type W series offer capacities from 4100 to 11,600 lb of steam per hour in the W-1 model and 11,400 to 23,500 lb in the W-2. The former features a two-pass vertical gas travel system and has a shorter furnace width for moderate capacity requirements. In the W-2, shown



above, gas travel is directed by a complete two-pass horizontal system designed to deliver a larger capacity economically. Standard design pressure for both models is 160 psi. Both units can be skidded into place and installed without special connections. Boiler Div., Wm. Bros Boiler & Mfg. Co.

16—DRAWING INSTRUMENT

Has special lead, for drawing uniform continuous straight lines

This time-saving graphite lead drawing instrument is composed of company's No. 9600 holder and No. 9040 drawing lead. This is a very thin, imported lead, held firmly in internal sections. It measures approximately 0.018 in. thick, 0.098 in. wide and 4 in. long, and is available in 11 degrees from HB to 9H. This lead never needs sharpening or sanding, company points out, and is especially suited to straight line drawing. A. W. Faber-Castell Pencil Co.

17—INSULATION TESTER

High voltage, d-c unit for ranges 0-15 kv, 30 kv, 45 kv and 75 kv

The TAKK High Voltage D-C Tester is described as portable, rugged and highly accurate; it is designed to prevent insulation breakdowns on all types of high voltage equipment by detecting insulation weaknesses before breakdowns can occur. This instrument tests at over or under the full operating voltage of the equipment under test and won't impair insulation. The John Hewson Co.

18—CHECK VALVE

For discharge line of air or gas compressors, operates automatically

Developed to prevent damage to the compressor, the PPC Aircheck Valve also acts as a safeguard against the failure of operating personnel to open a valve when starting up. Among other reasons cited by manufacturer for installation of this valve on compressor discharge lines are that it prevents leakage of pressure through the compressor during the "off" cycle; it dampens pipe line pulsations; and it permits repairs without shutting down the system where more than one compressor is on the line. It also permits more simplified installation, because stop and safety valves are not required. Pennsylvania Pump and Compressor Co.

19—FIRE EXTINGUISHER

For one-hand operation, features combination of charges

Charges for the new Redi-Grip Pressurized Portable Extinguisher may be CMB (chlorobromomethane) or carbon tetrachloride, individually or in combination, and the expellent may be either air or carbon dioxide. Company points out that the Redi-Grip may be released from its bracket and operated with one hand, while a safety lock prevents accidental discharge. Stop-Fire, Inc.

20—ELECTRONIC DETECTOR

Locates friction noises in bearings, pistons, gears, traps, pipes, valves

The Elec-Detec is an electronic stethoscope using a metal probe which serves as a microphone transmitting impulses electrically to headphones. It is designed to find the source of the noise, help diagnose the trouble and determine where to make repairs without tearing down the entire equipment.

According to manufacturer, the electric amplifier and sensitivity control on

the Elec-Detec makes it possible to detect sounds at low speed that could otherwise be heard only at high speeds. Even sounds not normally audible are clearly defined. Anco Instrument Div.

21—SPRAY COOLER

For refrigeration, storage of products requiring high humidity air

Offered especially for applications involving foods liable to dry out, shrink or discolor in cold dry air, this new No Frost Cooler differs from company's previous models in that the air enters through the fans and is blown through the units. The air passes over refrigeration coils and through a spray of No Frost Liquid solution to prevent the condensation of water and the formation of ice or frost on the coils. The chilled air, which may be as low as −20F, passes direct from the spray chamber into the room. Since it contains no reheat from the energy of the fans, higher humidity air is possible. Niagara Blower Co.

22—DIAPHRAGM SWITCH

Normally open or normally closed, actuated by gas pressure

The L-38 Low Pressure Switch is described as inexpensive and applicable to heating plant installations where it is necessary to operate a switch by a variation in gas pressure. In operation, pressure applied against a spring-loaded diaphragm tilts a mercury tube switch. Company says the diaphragm is made of material impervious to gases, including liquified petroleum gas, and the spring loading mechanism is adjustable by a set screw at the top cover plate. The control also has a built-in level in the top cover.

The L-38 is suitable for air or gas applications only, at rated pressures. Its operating point is adjustable over a pressure range of 3 to 12 in. of water and operates from pressure differential of 2 to 4 in. of water. General Controls Co.

23—SUBMERSIBLE PUMP

For small capacities at high heads from wells of 6 in. ID or larger

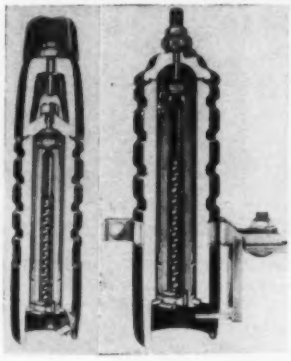
The Subette has a capacity range of from 30 to 130 gpm at heads of from 80 to 770 ft. The motors, available in 5, 7½, 10 and 15 hp, are three-phase, 60 cycle, two-pole, 220/440 v and have a speed of 2900 rpm. These motors are oil-filled, mechanically-sealed and designed to operate completely submerged in water. Byron-Jackson Co.

24—EXPULSION ARRESTER

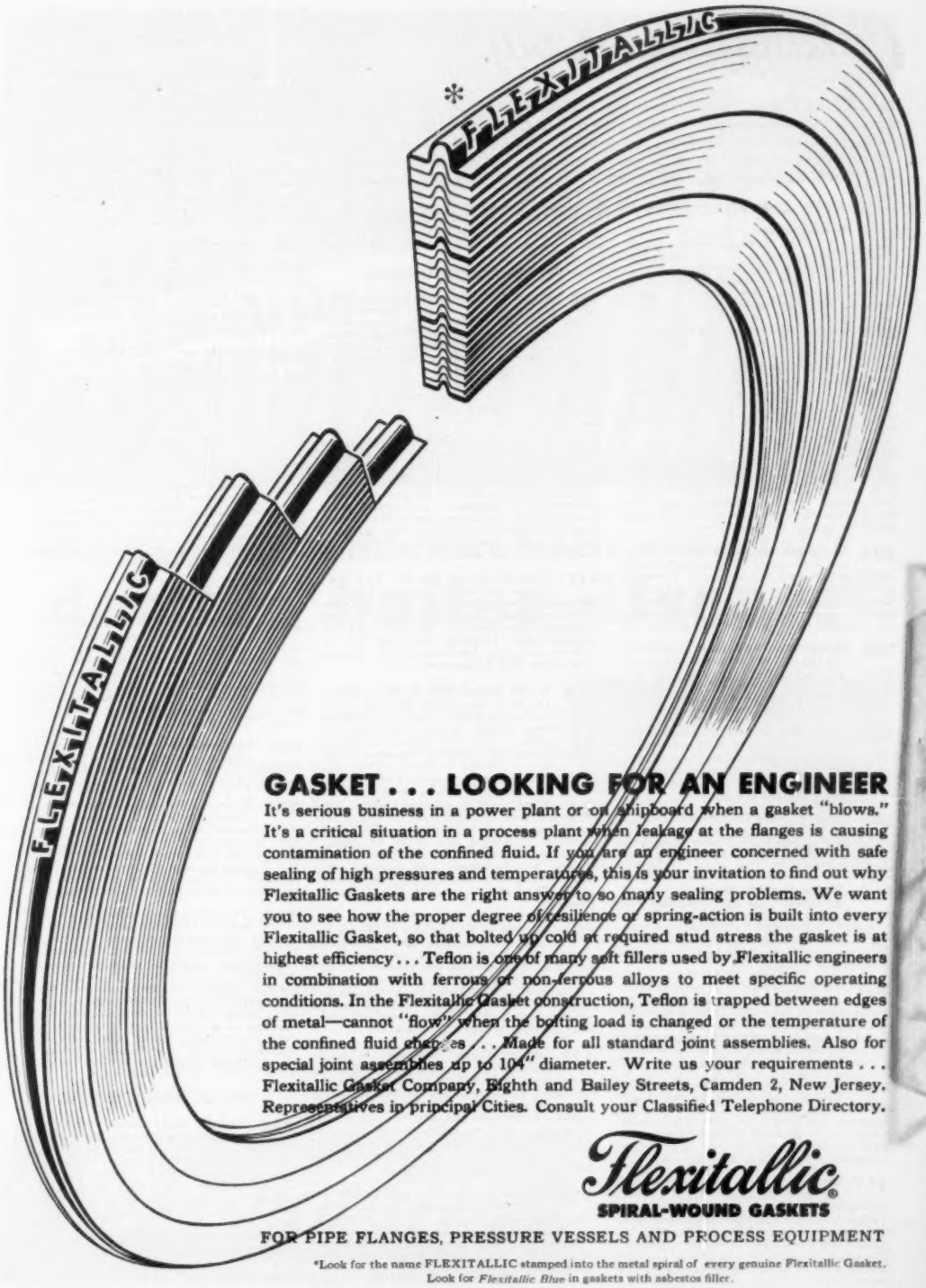
High capacity, for protecting distribution apparatus

This new lighting arrester, the Type LX, incorporates a new method of limiting power follow current on systems having fault currents up to 20,000 amp. A spiral fiber filler, heart of the arrester, is used to provide longer life and positive protection by lengthening the power arc to four times the original spark path. As a result, the power follow current is limited to a fraction of the available fault current.

Company engineers point out that although the arc path is lengthened, spark-over values are kept low by high field stresses between the upper electrode and the metal shield surrounding the arc chamber. A steel reinforced arc chamber and the spiral groove in the fiber filler, which store gases generated during surge discharge, make the arrester capable of withstanding surge currents in excess of 65,000 amp. The Type LX is currently available in ratings of 3,



6 and 9 kv. The top gap arrester (left) is designed for standard crossarm applications; the bottom gap arrester is for crossarm mounting and can be adapted for transformer mounting. Westinghouse Electric Corp.



GASKET . . . LOOKING FOR AN ENGINEER

It's serious business in a power plant or on shipboard when a gasket "blows." It's a critical situation in a process plant when leakage at the flanges is causing contamination of the confined fluid. If you are an engineer concerned with safe sealing of high pressures and temperatures, this is your invitation to find out why Flexitallic Gaskets are the right answer to so many sealing problems. We want you to see how the proper degree of resilience or spring-action is built into every Flexitallic Gasket, so that bolted up cold at required stud stress the gasket is at highest efficiency . . . Teflon is one of many soft fillers used by Flexitallic engineers in combination with ferrous or non-ferrous alloys to meet specific operating conditions. In the Flexitallic Gasket construction, Teflon is trapped between edges of metal—cannot "flow" when the bolting load is changed or the temperature of the confined fluid changes . . . Made for all standard joint assemblies. Also for special joint assemblies up to 104" diameter. Write us your requirements . . . Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey. Representatives in principal Cities. Consult your Classified Telephone Directory.

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SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* in gaskets with asbestos filler.

Catalog Library

THIS MONTHLY list of standard catalogs and bulletins is published to help power engineers maintain a permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the postage-paid card on pages 45 and 46 for your request

BOILERS AND AUXILIARIES

201 Steam Boilers — Form SG 128-749 is a 12 pp catalog illustrated with photos of steam boilers for processing and heating, ranging from 15 to 500 hp and 15 to 200 psi. Includes diagrammatic cross-section of four-pass design characteristic of manufacturer's boilers. Cleaver-Brooks Co.

202 Re-Circulation Steam Generator — Here's a 6-pp folder on a controlled re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or load fluctuating. Explains operation, features. Combustion Engineering-Superheater, Inc.

203 Packaged Generators — Bulletin SB-38 presents company's Keystone model. Photos and sketches show complete unit, pressure element and details of its compact design. Gives advantages of two-drum water boiler, three-pass gas travel, automatic gas or oil burner. Erie City Iron Works.

204 Shop-Assembled Boiler — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming. The Babcock and Wilcox Co.

205 Dowtherm Vaporizer — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

206 Tube Expanders — Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators, other equipment. Thomas C. Wilson, Inc.

207 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Roto Div., Elliott Co.

208 Streamlined Baffle Walls — Bulletin BW-44, 20 pp, describes company's baffle walls, showing their application to modern boilers and for modernizing existing units. Fully illustrated with photos and drawings covering installations, remodeling designs. The Engineer Co.

209 Air Preheaters — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's preheater, discusses its application to boiler plants. The Air Preheater Corp.

210 Soot Blower Head — Illustrated Bulletin 485, describes a rotary soot blower head for improved boiler cleaning. Explains how head is designed to give maximum blowing pressure, is rugged, easily serviced, economical. Vulcan Soot Blower Div., Continental Foundry & Machine Co.

211 Double-Walled Tubing — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations. Explains tubing's use in ammonia refrigeration, boilers, steam generators and other applications. Discusses heat transfer properties, high temperature use. Also discusses prevention of galvanic corrosion. Bridgeport Brass Co.

WATER CONDITIONING

214 Water Conditioning Information — Here are three informational bulletins. No. 28X7446 describes a simple way to determine total hardness in water, illustrating procedure. No. 28X7559 gives an analysis of the hot process-hot zeolite system, telling results to be expected. No. 28X7466 discusses current status of embrittlement in boilers, explaining causes and telling recent developments in control methods. List bulletins wanted. Allis-Chalmers Mfg. Co.

215 Modern pH and Chlorine Control — This 100-pp booklet gives details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

217 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50. Procedures, reagents, and equipment are described. Tells how tests determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

218 Boiler Water Treatment — Bulletin 47, 8 pp, defines internal treatment of boiler water and tells its advantages in softening, sludge conditioning, stabilization. Explains company's system, including the chemicals used. National Aluminate Corp.

219 Ion Exchange Systems — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering history, performance, and potential uses of Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchanges are explained. Also discussed are costs, quality of product, and rinse requirements. The Resinous Products Div., Rohm & Haas Co.

220 Chemical Treatment of Water — Bulletins describing various methods of chemical water treatment, including company's Coravol process, are available. Coravol is part of a complete technical service which provides special chemical formulae for boiler feed water, foam prevention, hot water supply, refrigerating brine, cooling and condenser water. Western Chemical Co.

221 Boiler Water Manual — Factual information on methods of applying chemicals in treatment of water for boilers is presented in 16-pp Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feed-water system, condensate returns, flushing. % Proportioneers, Inc.%

222 Water Softening Equipment — How problems caused by hard water can be offset by water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. The Permutit Co.

223 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blowdown adjustment, test control. Describes available equipment and includes reference bibliography of literature on specific formulations. Dearborn Chemical Co.

224 Boiler Corrosion — A 12-pp article discussing cause and prevention of corrosion in boiler systems is presented in Bets Technical Paper No. 111. The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity, physical factors are evaluated. W. H. & L. D. Bets.

225 Zeolite Water Softeners — Publication 4530, 16 pp, presents hydrogen zeolite (cation exchange) water softening equipment. Gives complete description of the process and the field of application, showing advantage of hydrogen zeolite softening and its relation to sodium zeolite softening process. Cochrane Corp.

226 Feedwater Treating — Bulletin 1855, 30 pp, features manufacturer's hot process Accelerator for use in treatment of boiler feedwater, illustrating and explaining its operation and advantages, also optional auxiliary equipment. Contains excellent discussion of the necessity of treatment of makeup water, selection of proper equipment. Also covers limitations of hot process softening. Infilco Inc.

227 Slurry Type Softener — Six-pp Bulletin W-212-B6 describes a slurry type precipitating softener and coagulator in which energy for floc preparation is mechanical, explaining and illustrating flow circuit. Question-and-answer appraisal of system. Worthington Pump and Machinery Corp.

ELECTRICAL

230 Power Factor Correction — Examples showing basic considerations in the improvement of system power factor are contained in Bulletin 05B7465. Points out advantages of improving plant power factor and advisability of keeping load power factor up to 0.8 lagging or higher; tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

231 Synchronous Motors — High speed synchronous motors are described in Bulletin PB 5600-1. Includes descriptive matter, photos showing features. Elliott Co.

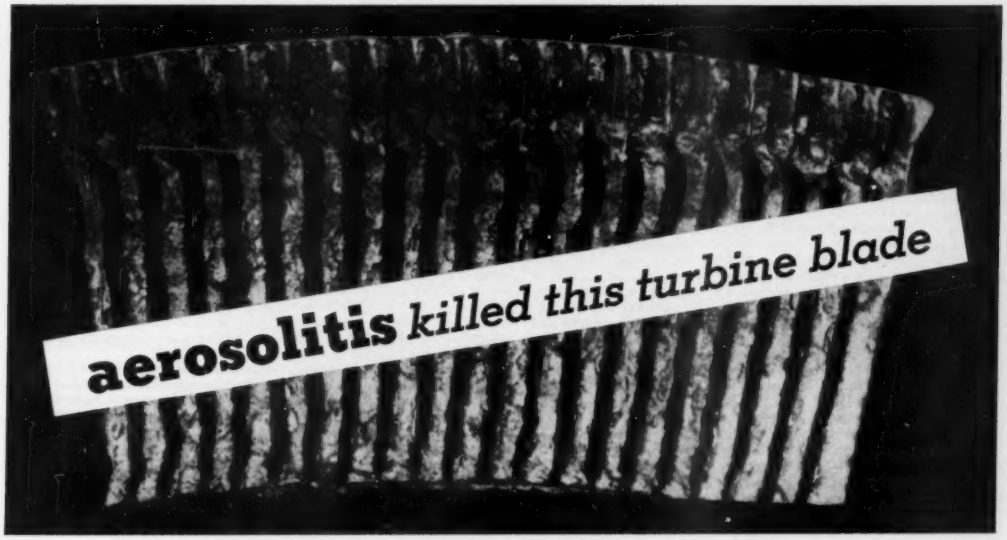
233 Buyers' Manual on Motors and Control — Fifty-pp Catalog GEC-1009 presents buying information on a carefully selected group of motors, motor starters, control accessories and electronic control. Ratings listed are those most frequently required. Excellent data on proper selection is provided. Illustrated. General Electric Co.

234 Co-ordinated Protection of Motors — The interlinked protection of circuits, motors and personnel is explained in 12-pp Bulletin DB-4673 on high-voltage combination starters. Because almost every 2300/4800 v power system can produce high currents under short-circuit conditions, booklet stresses this interlinked protection, covering three classes of combination motor starters: an air-break type for squirrel-cage induction motors; a starter with oil-immersed contactor, and a combination synchronous motor starter. Westinghouse Electric Corp.

VALVES, TRAPS, PIPING

236 Popular Steel Valves — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes — 150 to 2500 lb — and include globe and angle, gage, instrument, hydraulic and relief types, also strainers, and check, gate, non-return and blow-off valves. Explains design features. Edward Valves, Inc.

(Continued on page 138)



Dearborn polyamide anti-foams prevent this

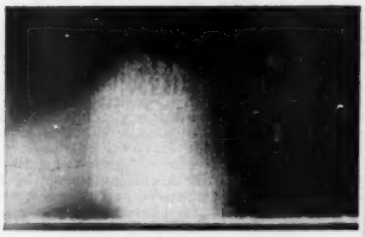
deadly boiler disease

Here is an unretouched photo of a turbine blade that was *killed by aerosolitis.* Replacement was, of course, both necessary and expensive.

But *aerosolitis*—more prevalent with some waters than with others—can be easily and inexpensively prevented with Dearborn Improved Polyamide Anti-Foams. In addition to inhibiting the formation of harmful *aerosols,* Dearborn Polyamide Anti-Foams prevent foaming to produce purer steam—eliminate scale formations—condition sludge —are compatible with other treatment.

IF YOU USE STEAM for power or process, investigate the time-, money-, and labor-saving advantages of Dearborn Polyamide Anti-Foams and the complete Dearborn Industrial Water Treatment and Engineering Service. A Dearborn engineer is at your service. The coupon is for your convenience.

DEARBORN CHEMICAL COMPANY
Merchandise Mart Plaza • Chicago 54, Illinois



AEROSOLITIS AT WORK

Aerosols are tiny drops of water dispersed in the steam which cause encrustation on superheaters, foul turbine blades. When this happens, boilers have *aerosolitis,* and costly shutdowns and repairs will result.

Dearborn Chemical Company, Dept. PG
Merchandise Mart Plaza
Chicago 54, Ill.

Gentlemen: Please send:

- ☐ Bulletin on Dearborn Improved Polyamide Anti-Foams
- ☐ Bulletin on Dearborn Industrial Water Treatment and Engineering Service
- ☐ Have a Dearborn Engineer call

Name.....

Company.....

Position.....

Address.....

City.....*State*.....

Dearborn
TRADE MARK REGISTERED
THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

POWER PLANT *Construction News*

San Leandro, Calif. — Crown Willamette Paper Co., 343 Sansome St., San Francisco, Calif., paper bags and other paper containers, paper towels, etc., plans boiler house at new converting plant at West Ave. and Merced St., San Leandro, where large tract of land has been acquired. Work will be carried out soon. Entire project is estimated to cost about $3,000,000. Company is a subsidiary of Crown Zellerbach Corp., first noted address.

Denver, Colo. — Public Service Co. of Colorado, Inc., 900 15th St., has disposed of bond issue of $15,000,000, proceeds to be used in part for expansion and improvements in plants and system. Extensions will be made in local Lacombe power plant, with installation of a new 60,000-kw turbine-generator unit and auxiliary equipment. Completion is scheduled in 1953.

Jacksonville, Fla. — Tennessee Products & Chemical Corp., American National Bank Bldg., Nashville, Tenn., coal tar and wood distillation products, industrial chemicals, etc., plans power house at proposed new plant on Edgewood Ave., Jacksonville, where site has been secured, for manufacture of perlite. Cost reported in excess of $450,000. Proposed to begin work soon.

Rome, Ga. — Rome Kraft Co., care of Mead Corp., 118 West First St., Dayton, Ohio, paper products, recently organized joint interest of that corporation and Inland Container Corp., 700 West Morris St., Indianapolis, Ind., plans power house at new container board mill at Rome, where large tract of land has been acquired. Mill will comprise several large units and will have a rated output of 650 tons of paperboard products per day. It is scheduled for completion in summer of 1953. Cost reported about $25,000,000.

Valdosta, Ga. — National Container Corp., 30-01 Review Ave., Long Island City, New York, N. Y., corrugated boxes and containers, etc., plans power house at new pulp and paper mill at Valdosta, for manufacture of paperboard products. It will comprise several large production units, with rated output of 500 tons per day. Cost reported close to $25,000,000. Work will proceed at once and is scheduled for completion by end of 1952.

Maunee, Ill. — Association of Illinois Electric Cooperatives, 524 East Capitol St., Springfield, Ill., plans new steam-electric generating station on Wabash River, near Maunee. Cost reported close to $5,000,000. Laramore & Douglass, 79 East Adams St., Chicago, Ill., are consulting engineers.

Peoria, Ill. — Central Illinois Light Co., 316 South Jefferson Ave., is arranging financing in amount of about $8,000,000, through sale of bond issue, proceeds to be used in connection with expansion and improvements in plants and system over a period of months, including extensions in Wallace steam-electric generating station on Illinois River, now in progress.

Rock Island, Ill. — Iowa-Illinois Gas & Electric Co., Rock Island, has arranged for financing in amount of $6,000,000, proceeds to be used for expansion and improvements in plants and system, including increased generating facilities.

Tuscola, Ill. — National Petro-Chemicals Corp., care of National Distillers Products Corp., 120 Broadway, New York, N. Y., recently organized as a joint interest of that company and Panhandle Eastern Pipe Line Co., 1221 Baltimore St., Kansas City, Mo., plans power house at proposed new plant at Tuscola, where site has been secured, for production of petrochemicals. It will comprise several large units. Entire project is reported to cost close to $30,000,000. Work is scheduled to begin soon.

Fort Wayne, Ind. — Salisbury Axle Division, Dana Corp., 3100 Bennett Rd., Toledo, Ohio, automobile axles and kindred products, plans power house at proposed new plant at Fort Wayne, comprising a main one and two-story building, about 400,000 sq ft manufacturing area. Cost reported over $5,000,000. Work will be placed under way soon. A. Bentley & Sons Co., 201 Belmont St., Toledo, is engineer and contractor for erection.

Augusta, Me. — Central Maine Power Co., Augusta, has arranged for bond issue of $7,000,000, portion of proceeds to be used for expansion and improvements in plants and system.

Iron County, Mich. — Wisconsin-Michigan Power Co., Appleton, Wis., plans new hydroelectric power plant at Michigamme Falls, Michigamme River, Iron County, comprising a 1390 ft power dam, reservoir of 5650 acres and power station with two hydraulic turbines, each 6500-hp rating and two generators, each 4800-kw capacity. Work will begin soon and is scheduled for completion by end of 1952. Permission has been granted by Federal Power Commission.

Jackson, Mich. — Consumers Power Co., Jackson, has arranged for financing in amount of about $18,000,000, through sale of stock issue, proceeds to be used for expansion and improvements in power plants and system. Company will soon begin work on extensions in Justin R. Whiting and John C. Weadock steam-electric generating stations for increased capacity, recently noted in these columns.

Cleveland, Miss. — Mississippi Power & Light Co., Lampton Bldg., Jackson, Miss., plans new steam-electric generating plant in vicinity of Cleveland, with turbine-generators, high-pressure boilers and auxiliary equipment for large capacity, exact rating now being determined. Cost reported close to $20,000,000, including power substations, transmission lines, etc.

Gaston, N. C. — Virginia Electric & Power Co., Franklin and Seventh Sts., Richmond, Va., plans new hydroelectric generating station on Roanoke River, near Gaston, where site has been selected. It will be equipped for rated capacity of about 90,000-kw, and is reported to cost approximately $27,500,000. Application for permission has been made.

Spencer, N. C. — Duke Power Co., Charlotte, N. C., has approved plans for expansion in Buck steam-electric generating plant at Spencer, including installation of turbine-generator units with capacity of 270,000-kw, high-pressure boilers and auxiliary equipment. Work will proceed at once, with completion scheduled in spring of 1953. Entire project is reported to cost about $30,000,000.

Kenmare, N. D. — Board of Education has plans for addition to power plant used for central steam-heating service for schools, with installation of additional equipment for increased capacity. Work will be carried out soon. No estimate of cost announced. Ritterbush Brothers, 209 Seventh St., Bismarck, N. D., are architects.

Maple Grove, Ohio — Basic Refractories, Inc., Hanna Bldg., Cleveland, Ohio, refractory shapes and products, plans power house at proposed new plant at Maple Grove, where site has been selected. Entire project is reported to cost over $3,500,000. McDonald Engineering Co., 188 West Randolph St., Chicago, Ill., is consulting engineer. Work is scheduled to begin soon.

Tulsa, Okla. — Public Service Co. of Oklahoma, 600 South Main St., has engaged Sargent & Lundy, 140 South Dearborn St., Chicago, Ill., consulting engineers, to prepare plans for proposed new steam-electric power plant, recently referred to in these columns. Cost reported in excess of $9,000,000. It is expected to begin work in 1952.

Medford, Ore. — California-Oregon Power Co., Medford, Ore., plans to begin construction of new hydroelectric power plant on Klamath River, site selected, as soon as permission has been granted by Oregon State Hydroelectric Commission and Federal Power Commission, expected at early date. Plant will be equipped for a capacity of 50,000-kw, and is reported to cost in excess of $15,000,000, with switching stations and transmission lines.

Philadelphia, Pa. — Gulf Oil Corp., 1515 Locust St., plans new electric generating station at oil refinery at 30th St. and Penrose Ave., with installation of a 30,000-kw turbine-generator, high-pressure boiler and auxiliary equipment. Work will be carried out in conjunction with expansion in refining plant, entire project reported to cost over $25,000,000. Completion is scheduled early in 1953. Main offices are in Gulf Bldg., Pittsburgh, Pa.

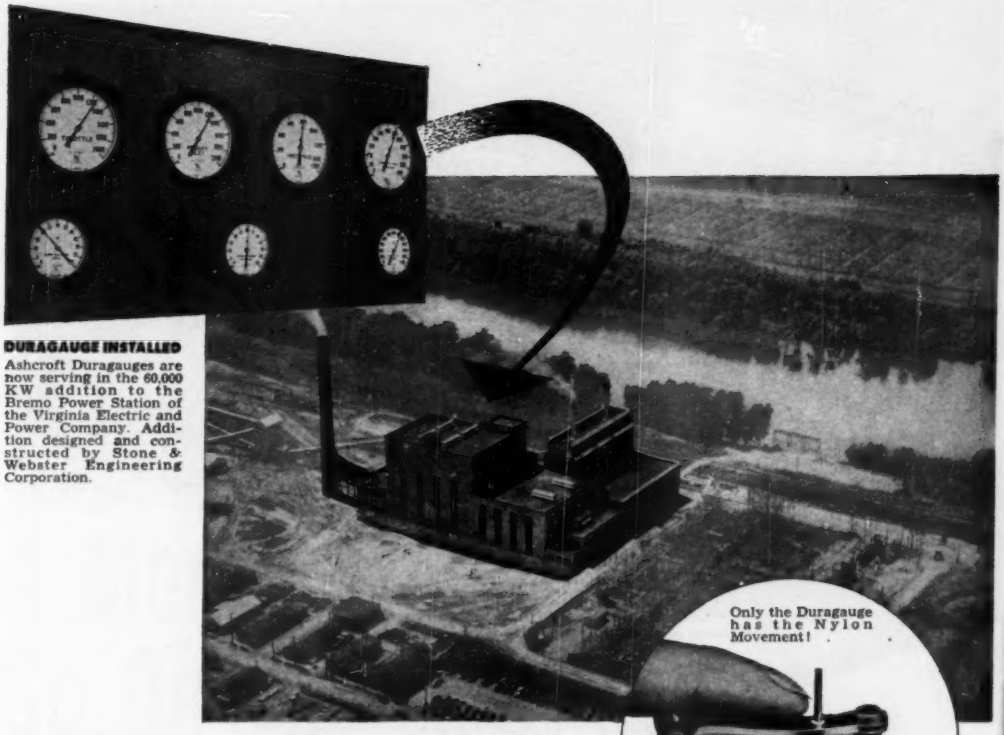
Philadelphia, Pa. — Philadelphia Electric Co., 1000 Chestnut St., is arranging an expansion and improvement program to be carried out over a period of 60 mos, concluding in 1956, including generating stations, power substations, transmission and distribution lines, and other operating facilities. In that time it is proposed to increase present generating capacity by 800,000-kw. Entire program is estimated to cost $365,000,000.

Springdale, Pa. — West Penn Power Co., Pittsburgh, Pa., plans expansion in steam-electric generating station at Springdale, with installation of new 135,000-kw turbine-generator unit, high-pressure boilers and auxiliary equipment. Proposed to begin work in 1952, with completion scheduled early in fall of 1953. Cost reported about $17,000,000.

Houston, Tex. — Alamo Chemical Co., care of Phillips Chemical Co., Adams Terminal, Houston, recently organized by that company and General Aniline & Film Corp., 230 Park Ave., and Borden Co., Chemical Division, 350 Madison Ave., both New York, N. Y., as a joint interest, plans power house at proposed new plant on Houston Ship Channel, Houston, for production of anhydrous ammonia. Entire project will cost about $38,000,000.

Albright, W. Va. — Monongahela Power Co., Fairmont, W. Va., plans expansion in new steam-electric generating station now in course of construction at Albright, and scheduled to be ready for service next June. New installation will comprise a 135,000-kw turbine-generator and auxiliary equipment; work will begin late in 1952, and is scheduled to be completed early in fall of 1954. Project is reported to cost approximately $17,000,000. Plant is being constructed by Monongahela Company and Potomac Edison Co., Hagerstown, Md., an affiliated interest, both subsidiaries of West Penn Electric Co., Pittsburgh, Pa.

Milwaukee, Wis. — American Hair & Felt Co., 944 North 46th St., has approved plans for addition to power house at factory, with installation of equipment for increased capacity. Cost about $300,000. Gates, Moe, Weiss & Papenthein, 611 North Broadway, Milwaukee, are architects and engineers.



DURAGAUGE INSTALLED

Ashcroft Duragauges are now serving in the 60,000 KW addition to the Bremo Power Station of the Virginia Electric and Power Company. Addition designed and constructed by Stone & Webster Engineering Corporation.

☑ **Sustained Accuracy** ☑ **Improved Sensitivity** ☑ **Longer Service Life**

THE ASHCROFT *Duragauge* ASSURES ALL THREE!

Eliminate excessive weight and mass of parts in designing a pressure gauge and you achieve new standards of accuracy, sensitivity and service life.

Ashcroft engineers attained these objectives in the Duragauge *Nylon Movement**. Bearings and pinion gear are light, strong, dimensionally stable *nylon*. Friction and wear are minimized. Resistance to corrosion is increased. Shock impact absorption is improved. Advantages to you: sustained accuracy, greater sensitivity, low maintenance and longer service life. The Ashcroft Duragauge, with Nylon Movement, outwears all others.

Since its introduction in 1947, the Nylon Movement has been widely recognized for unmatched performance in "killing" services in power stations, refineries and chemical plants. Ask your Ashcroft Distributor for all the facts. He will gladly help you select the right Duragauge for your specific needs.

* Patented

1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

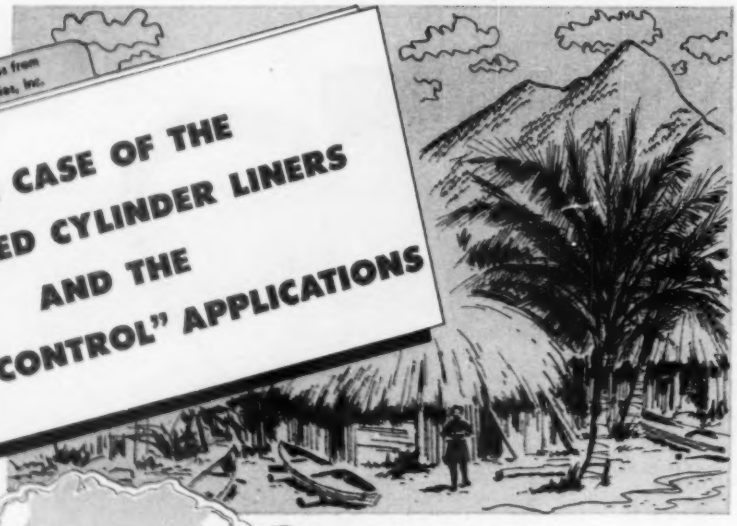
MAXWELL MM&M MANNING MAXWELL & MOORE INC. TRADE MARK

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

One of a series of case histories from the records of Hall Laboratories, Inc.

THE CASE OF THE CORRODED CYLINDER LINERS AND THE "REMOTE CONTROL" APPLICATIONS



Less than 300 kilometers from Caracas, Venezuela, is a growing town of 125,000, where Diesel engines provide the major source of electric power. This installation contains closed water systems for engine jacket cooling, which exchange heat to open, circulating cooling systems utilizing conventional wooden towers.

With rapidly growing power demands, water-related problems reached an acute stage. On the water side of the cylinder liners, severe corrosion evidenced itself as partial graphitization. Heavy scale formed rapidly in heat exchangers. Water storage tanks were fouled with organic growths. Plant efficiency became markedly impaired.

Fortunately, a Hall engineer had just made a survey of the cooling water system. So, the Plant Superintendent arranged immediately to follow the advice of Hall Laboratories.

For the open system Hall recommended the use of Calgon and algicide with proper control of pH and blowdown. For the closed engine jacket system chromate and wetting agent were specified with control of pH.

The Plant Superintendent made tests, kept logs, and sent samples and reports to Hall via air mail. This splendid "remote control" cooperation between the superintendent and his staff and Hall Laboratories now makes possible such reports as "The liners of No. 1 Engine pulled. No evidence of corrosion" and "No need to clean heat exchangers this month."

Now, new engines and cooling systems are going in and they will be properly protected from the ravages of scale and corrosion, right from the start.

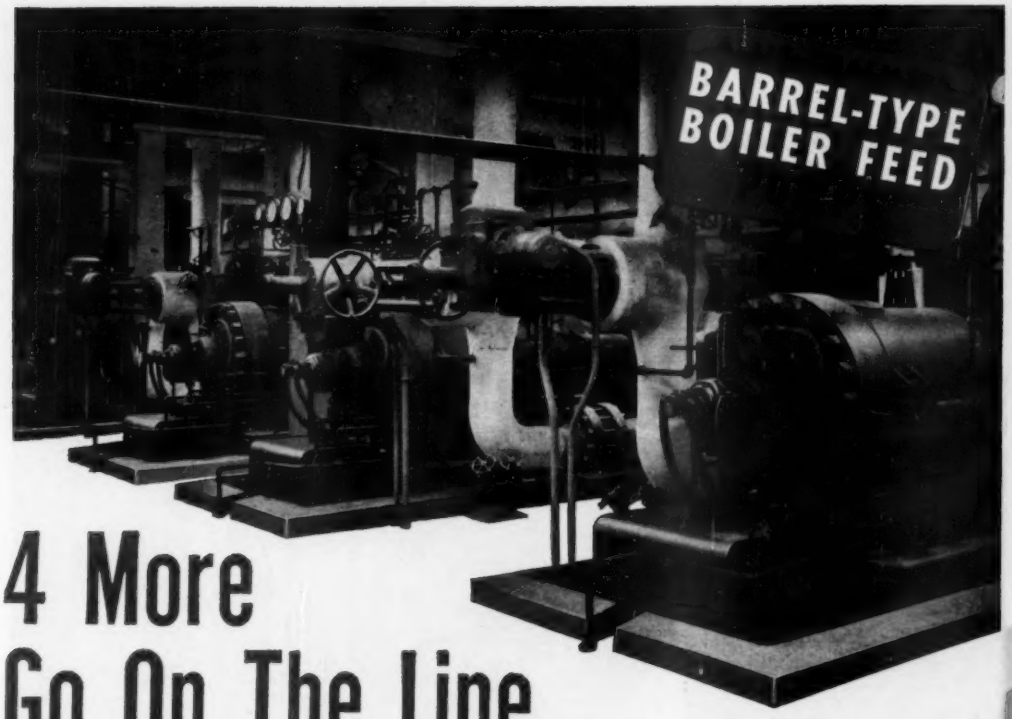
This is another example of how Hall Laboratories serves industry wherever water problems occur. Years of experience with industrial water problems prepare Hall Engineers to help you solve yours. For information, write to Hall Laboratories, Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

HALL PLANT WIDE WATER SERVICE

Consultants on Procurement, Treatment, Usage and Disposal of Industrial Water



4 More Go On The Line

AT NEW HAWTHORN STATION, KANSAS CITY

Over 50 of these pumps have been bought by utilities on their proved performance record.

NEWEST PLANT OF KANSAS CITY POWER & LIGHT CO. is the Hawthorn Steam Electric Station on the Missouri River. This station, designed with every modern feature for dependability and low cost operation, has an initial capacity of 132,000 kw from two turbines and is already building an addition that will add almost another 100,000 kw from one additional turbine.

The boiler feed pump arrangement, pictured above, consists of four Allis-Chalmers 8" x 8" barrel-type boiler feed pumps with a capacity of 700,000 pounds per hour each at a discharge pressure of 1625 psig. They are driven by 1750 hp, 3600 rpm motors.

The unit now under construction also will be served by Allis-Chalmers barrel-type boiler feed pumps. Three pumps with a capacity of 425,000 pounds per hour at 1815 psig driven by 1250 hp, 3600 rpm motors are now being built.

Engineering Features

Unique engineering features designed to increase reliability and reduce maintenance have been proved in operation. Single-stage, back-to-back impellers balance axial forces without the use of a balancing drum. First stage has twin, half capacity impellers to give the advantages of low NPSH. Expansion joint is brought to the outside of the pump where leakage may be quickly detected and adjustments made without dismantling the pump. No flexible internal members are required to compensate for expansion.

Sizes range from 1200 to 3000 psig and from 300 to 2500 gpm. Allis-Chalmers can supply the complete boiler feed pump installation including pump, motor and control of coordinated design and manufacture.

Get the details on this modern-design, performance-proved boiler feed pump from your Allis-Chalmers District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3522

ALLIS-CHALMERS A-C ALLIS-CHALMERS

IMMEDIATE STEAM

Introducing the Newest Idea

IN STEAM GENERATION!

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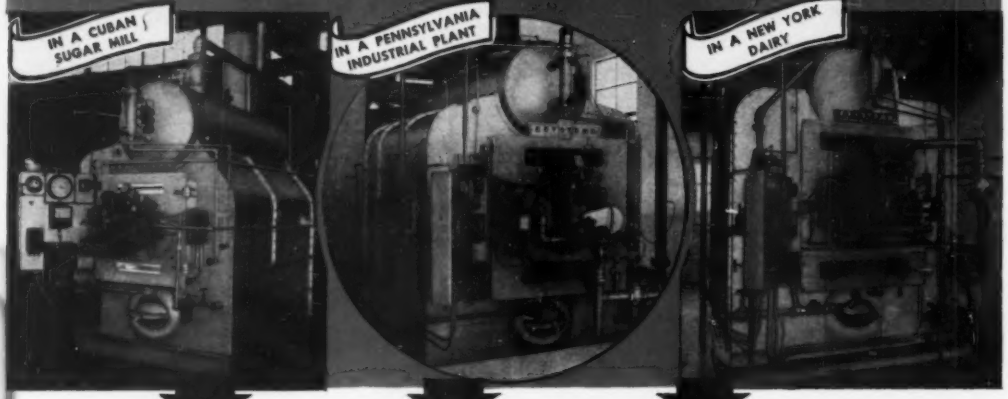
KEYSTONE

STEAM GENERATOR



Developed Boiler Horse Power	75*	100	150	200	250	300	350	400	450	500	600	700	800
Heating Surface Sq. Ft.	357	500	750	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000
*Capacity Lb./Hr.	2490	3320	4980	6640	8290	9950	11,610	13,290	14,940	16,620	19,930	23,220	26,550
Overall Length — A	14'-10"	14'-10"	19'-6"	19'-6"	20'-0"	22'-0"	22'-0"	23'-0"	24'-8"	25'-0"	25'-6"	25'-6"	26'-4"
" Width — B	6'-3"	6'-6"	7'-1"	7'-8"	7'-8"	7'-8"	8'-9"	8'-9"	8'-9"	9'-0"	9'-8"	10'-3"	10'-3"
" Height — C	9'-5"	9'-9½"	9'-9½"	10'-3¼"	10'-3¼"	10'-3½"	11'-3¼"	11'-3¼"	11'-3¼"	11'-3¼"	12'-7¼"	12'-7¼"	12'-11½"
Upper Drum Dia.	34"	34"	34"	34"	34"	34"	34"	34"	34"	34"	38"	38"	38"
Lower Drum Dia.	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	28"	28"	28"
Dia. Gas Outlet	10"	12"	14"	16"	18"	20"	22"	24"	26"	28"	30"	32"	34"
Shipping Weight Lbs.	20,000	22,000	25,000	27,000	28,000	30,000	33,000	36,000	44,000	52,000	60,000	65,000	70,000

*Based on Feed Water at 212°F and Steam at 100# psi. *Conservative ratings based on 5 sq. ft. per developed hp.*

It's a 2-drum water tube boiler with integral water cooled furnace. Gases travel 3 lengths of the boiler—scrubbing 5 bare metal heat absorbing zones. It's complete—needs only service connections—burns oil or gas or both—requires no stack—no special foundation.

Write for booklet **SB38B.**

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

Not an instrument you buy... but a service we supply

Now *within seconds* you can get an accurate and complete picture of combustion conditions in your furnaces. A Cities Service Combustion Engineer, by applying his *exclusive* Heat Prover, will quickly secure continuous, accurate readings that reveal any oxygen excess or waste combustibles present.

Operators throughout the country, by using these instant readings as their guide, have been improving furnace output and product quality, while saving fuel.

Similar results are possible at your plant. Start the ball rolling today for a FREE Heat Prover test of your furnaces. Simply call or write your local Cities Service office . . . or else return the coupon below.

THE COMPLETE CITIES SERVICE LINE FOR THE METAL FABRICATING INDUSTRY INCLUDES

Chillo Cutting Oils — Trojan Greases
Trojan Gear Oils — Optimus Cylinder Oils
Pacemaker T Hydraulic Oils
Q-T (Quenching and Tempering) Oils

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Without obligation please send your booklet, "Combustion Control for Industry."

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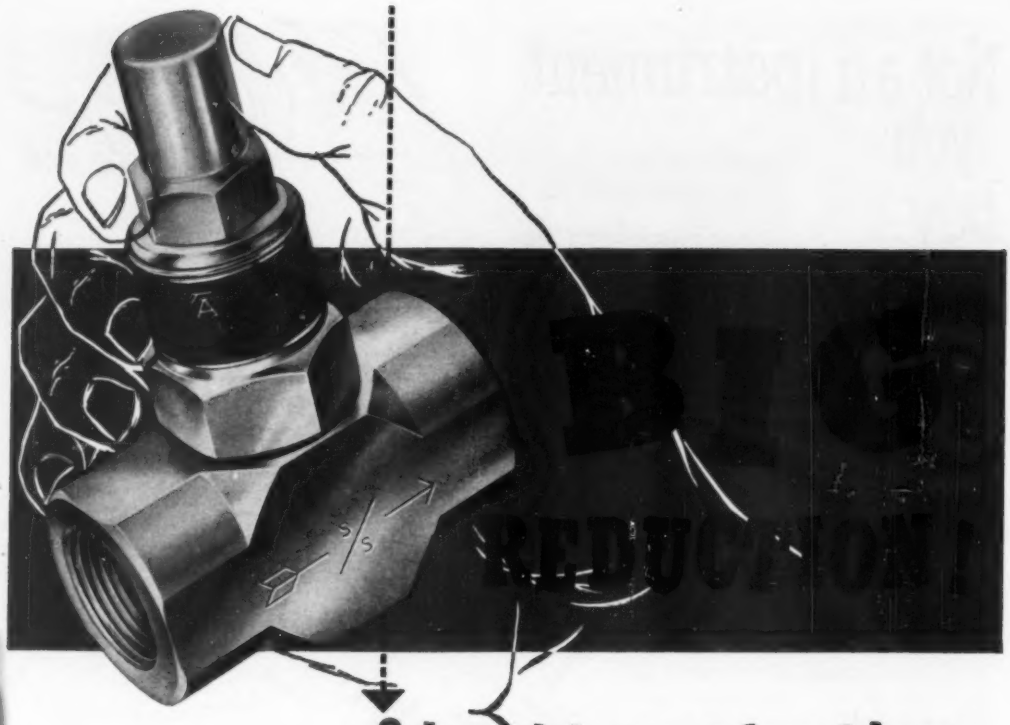


8-hour job now takes 4 hours

At a western magnesium reduction plant something besides magnesium has just been reduced. The steam at the end of the 1½ mile long steam line wasn't so hot—and neither was the production record of the plant at that location.

Then 26 old-type steam traps were replaced with Yarway Impulse Traps. Now there is only a 15° temperature drop from the boilers to the end of the line. *Most important, the plant 1½ miles from the boilers is now able to do work in 4 hours that previously took 8 hours.*

That's trap efficiency! It's evidence of the fact that Yarways are designed to send the most premium B.T.U.'s at top temperatures into your process of product. *They get equipment hotter, sooner . . . and keep it hot.*

Other Yarway features—small size, one moving part, easy installation, low maintenance, low cost, stainless steel construction. Nearly 750,000 Yarways have already been installed. For your Yarways, see a nearby industrial distributor . . . 216 stock and sell Yarways.

YARNALL-WARING COMPANY, 114 Mermaid Ave., Philadelphia 18, Pa.

FREE TRAP SELECTOR

It's important to have the right trap in the right place. Now 20-page selector tells quickly and easily which *is* the right Yarway trap for any application. Write for your free copy.

the steam trap designed with more production in mind

LETTERS TO THE EDITORS

SYNCHROSCOPE

IN YOUR article on Instruments and Controls for Small A-C Generators by D. L. Gusler, July issue, I notice he states that the purpose of a synchroscope is to indicate phase sequence.

A synchroscope does not indicate phase sequence, but phase relation and relative frequency. The job of determining phase sequence of a machine lies with the installing engineer. After this has once been checked and the machine properly connected to the breaker, it is impossible to change without reversing the rotation of the machine or interchanging the connections of two leads of the generator.

Carlsbad, N. M. ERNEST SHAFER, JR.

Editor's Note:—Reader Shafer is perfectly right, and we should have corrected Mr. Gusler ourselves. We know better and our faces are crimson. Nevertheless, we have a feeling that Mr. Gusler knows the true function of the synchroscope but picked the wrong word, which we failed to spot.

SHORTAGE

IN ADDITION to the material shortages we are all facing, resulting in the necessity for and the operation of the Controlled Materials Plan, the engineering manpower shortage is also causing much concern in both industrial and governmental circles. The Engineering Manpower Commission of the Engineer's Joint Council is hard at work on the second problem.

As everybody knows by this time, there was a current 1950–1951 demand for about 80,000 engineers in industry, independent of those needed in uniform. Against this need, there were graduated 38,000 men, half of whom were committed or subject to military duty. Best estimate is that we will need about 30,000 engineers a year for the next decade.

If all these figures are correct, what should the engineering profession do? Some engineers say the figures are exaggerated, that there is always a shortage of good engineers, that much of the demand is for specialists who already know their specialties and not for men who must have long training in them.

Also it is pointed out that there is a large number of technical jobs for personnel of moderate training and it may be that many of these are incorrectly classed as engineering.

Yet the industrial and governmental bodies surveyed insist that their figures are not inflated. And there is no other way to get figures, except from them.

So it looks as though the engineering manpower shortage is real.

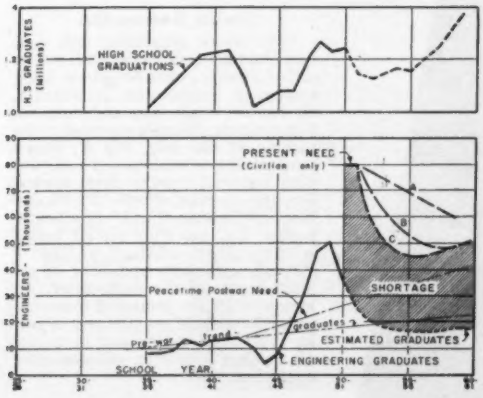
How is all this going to affect power engineers? Will we have to establish power plant training courses, like those under EMWT during the last war, to speed up training for operators?

Won't we have to have a definite policy, both in the military and civilian organizations, to promote most effective utilization of engineers?

There is at present much heat on the subject but not much light. Let's have some light from POWER ENGINEERING readers.

Most of the advertisements you see pleading for engineers to come and work for the McGoofus Mfg. Company, in a sort of engineers heaven (described in detail), contain two words: "qualified" and "experienced." Is it those two words that are causing the shortages? Is there an overall shortage of all kinds of engineers and technicians or merely of experienced ones? If the latter, is that news? Also, is it bad? Many of us remember when "Engineers were a dime a dozen!"

Minneapolis, Minn. C. R. EVANS



Graph included in The Engineering Shortage Continues, by S. C. Hollister; *Journal of Engineering Education*, October 1951, shows the trends clearly

Editor's Note:—For latest information on causes of, and remedies for, the prevailing engineer shortage, read the report of the EMC of EJC in *Journal of Engineering Education*, October 1951 issue, by Dean S. C. Hollister, President of ASEE; and another by M. H. Trytten, of National Research Council.

Also consider the accompanying curve presented by Dean Hollister.

Finally, cooperate with your national engineering society in any work it proposes to do to encourage high school students and any other young men (and women, perhaps!) to consider engineering careers.

The office of Defense Mobilization, in cooperation with the Selective Service (draft boards) and all the scientific and engineering bodies concerned, has set up a Committee on Specialized Manpower.

These groups furnish, for the first time, official bodies for dealing at high policy levels with this important topic.

STARTING UP

MANY NEW steam and power generating units are starting up now, and have been started up during the past couple of years. One of the problems (but only one) in such start-ups is how to get enough perfectly clean condensate or distilled water for the initial flushing out and filling of the new boilers.

There has been some discussion of this in various technical meetings of engineers, but strangely enough this information does not seem to get spread around enough. To my astonishment, I recently heard that one of the new stations had some trouble with silica carry-over after starting up because not enough care was used in procuring clean condensate for initial use.

This precaution is necessary to prevent silica from getting into the circuit and carrying over into the turbine. In new equipment, there is always the chance that dirt and sand will get into equipment parts that may be lying around in the plant and outdoors on the ground before assembly. Even with the best of care and protection of the equipment, there is always a chance of this. Hence the need for initial flushing and filling with clean condensate.

If the plant already has a way of providing condensate from existing equipment, that solves the problem. Some plants have extra evaporation and storage capacity, or have deionizing systems adequate for the purpose.

But many do not. In one recent new plant, clean condensate from another plant was trucked several miles by a fleet of glass-lined milk trucks, to start the new plant.

The subject is important enough to warrant some discussion of what was done about it in a number of recent start-ups. Perhaps a symposium?

Chicago, Illinois A. B. FORTMAN

Rural

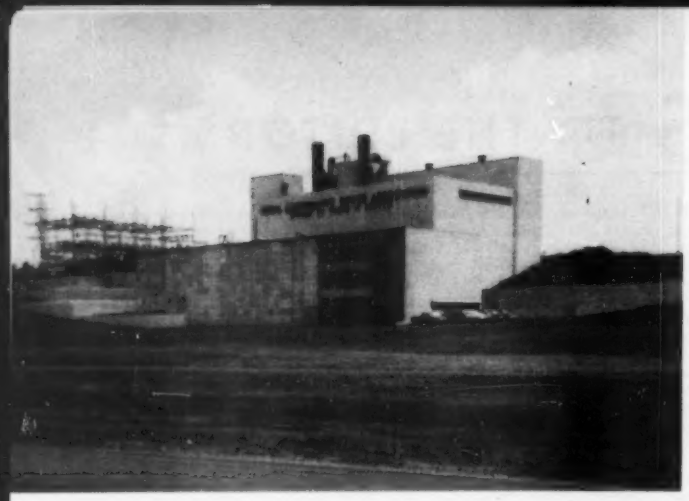


Fig. 1. This is the new Elk River Steam Plant. Ultra modern in its architectural features, the plant is bound to attract the attention of motorists who should be traveling the main highway between the Twin Cities and the recreation area of Northern Minnesota on which it is located

RURAL COOPERATIVE POWER ASSOCIATION'S latest power station, Elk River Steam Plant,stands on U. S. Highways 10, 52 and 169 on the east side of the Mississippi River, a half mile south of Elk River, Minnesota, and 30 miles up stream from Minneapolis.

This power cooperative serves nine distribution cooperatives. These have a present membership of approximately 25,000 farmers. They also furnish electrical service to the towns of Pine City, Milaca, Cambridge, Rush City, Onamia, and Isle.

In addition to the steam plant, the power cooperative owns and operates diesel-electric plants having a total capacity of approximately 20,000 kw. These plants are located at Hawick, Maple Lake, Cambridge, Milaca and Pine City. The units in these plants will be used for "peaking," voltage regulation and emergency standby operation.

Besides the large membership of the distribution cooperatives associated in this power cooperative, and men in the power plant field, who will visit this plant, its unique location will attract many other visitors every year. Located on the main highway between the Twin Cities and the recreation area of the northern part of the State, the normal traffic flow by the plant averages over 6000 cars daily, with peaks more than double this number on holidays.

Provision has been made for handling a large number of visitors without interfering with plant operation. In addition to a large reception lobby at the turbine room floor level, an observation gallery, reception room, toilet and kitchen facilities have been provided directly above in the space over the lobby, offices, switchboard and load dispatcher's rooms.

The plant design incorporates the unit system, with a single steam generator supplying a single turbine. Initial installation has two 120,000-lb-per-hr steam generators feeding two preferred-standard 11,500-kw turbine generator units. These units were placed in operation in April 1951. The plant is designed for a future unit that will bring the station to an ultimate capacity of 38,000 kw.

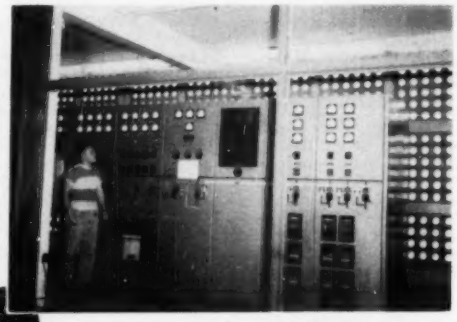


Fig. 2 (Right). A view of the main switchboard. Note the insulating concrete panels with glass inserts. This wall faces the highway and provides an attractive visual effect at night from the interior lighting

Fig. 3. (Below). A view showing the two Elliott Co., preferred standard, 11,500-kw turbine generators and the associated control panels

Steam Generation

Each steam generating unit consists of a two-drum boiler with water-cooled furnace, spreader-stoker firing equipment, superheater, economizer, air heater, draft fans and combustion controls. Steam is supplied to the turbine at 600 psig, 825 F. Steam temperature is maintained constant with automatic spray type control through injection of boiler feed water into an intermediate superheater header. Exit gas from the air heater is maintained constant at 300 F through automatic bypassing of gas around part of the economizer. Air heater tubes are protected from corrosion at the cold air inlet end in part by the above and in part by a cold air bypass which is automatically controlled.

Cooperative Power Association's Elk River Steam Plant

Attractively designed power station near Minneapolis, Minnesota, is newest addition to a cooperative power system supplying some 25,000 farmers. Since its location on a main highway into the Twin Cities is expected to attract many visitors, special attention was given the architectural features both inside and out. The initial installation consists of two 120,000-lb-per-hr boilers feeding two preferred standard 11,500-kw generating units. Burning coal at present, the plant is designed for future use of North Dakota lignite, ultimate use of natural gas

By A. C. HUNTER President, Ralph D. Thomas and Associates, Inc., Minneapolis, Minn.

With the exit gas temperature maintained constant at all loads, the fireman need only make minor adjustments in the controller of the forced draft air supply to maintain the highest CO_2 consistent with the load and fuel being burned, and so maintain maximum operating efficiency of the unit. Within the normal load range, this should not vary more than ½ per cent.

Performance calculations from which the steam generator design was developed gave the following efficiencies at the full load point of 120,000 lb per hr of steam: North Dakota lignite — 80.0 per cent; Southern Illinois coal (12,050 Btu per lb) — 86.0 per cent; Bunker "C" fuel oil — 87.0 per cent; natural gas — 82.5 per cent.

Automatic combustion controls maintain the desired steam pressure by regulating the fuel supply and the speed and dampers of the forced-and-induced-draft fans. The boiler panel board has mounted on it all combustion controls, pressure and temperature gages and recorders, switches, and all soot blower controls. In addition, there are mounted on it a Reliance "Eye-Hye" remote water-level indicator, a Hayes combination CO_2 recorder and indicator, a Hays water level recorder and a Brooke smoke indicator and control unit. This control unit is actuated by the smoke indicator, and through electric power units, adjusts the overfire air supply as required to eliminate the smoke. It is synchronized with the fuel feed controller so that it adjusts for load changes without time lag.

Air type soot blowers serve the boiler, economizer and superheater. All soot blowers are of the automatic sequential type with the superheater soot blower elements of the retractable type. The coal handling system provides for receiving coal by rail or by truck. The coal is stored by drag conveyor or bulldozer and is reclaimed with this equipment to the main belt conveyor or through an auxiliary bucket elevator. The capacity is ample for future handling of North Dakota lignite. Natural gas will ultimately be available. Boiler fronts are arranged for future installation of gas burners above the pres-

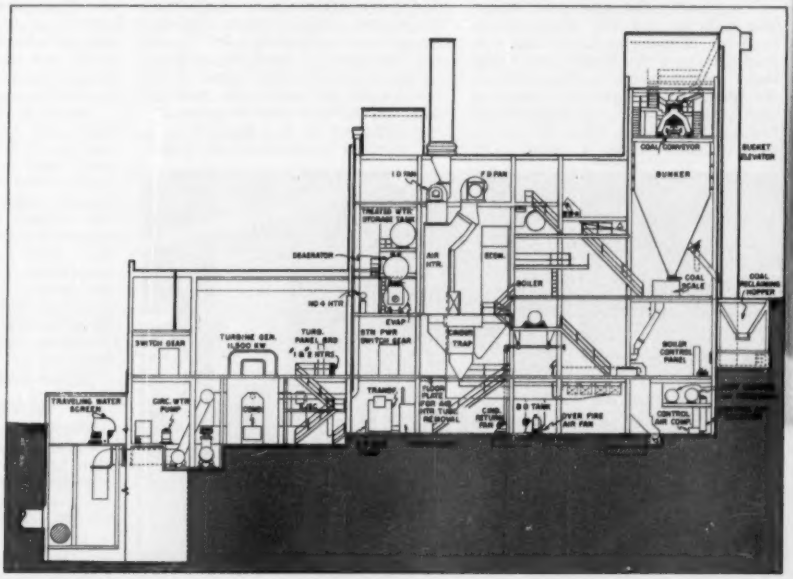


Fig. 4. Cross section of the plant. The coal handling system at the right has ample capacity for the future handling of North Dakota lignite

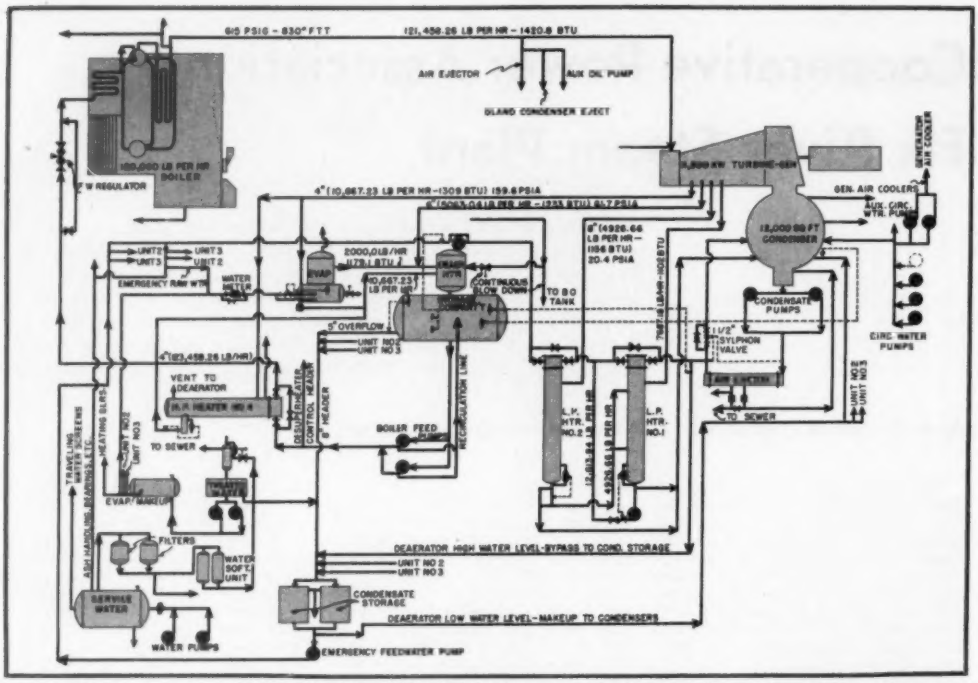


Fig. 5. Flow diagram. Steam is supplied to the main turbine at 600 psig, 825 F. Steam temperature is maintained constant by automatic spray type control through injection of feedwater into an intermediate superheater header

ent stoker hoppers. Ashes are removed through a pneumatic ash handling system and trucked from the ash silo.

Water Supply

The plant water supply for boiler feed make-up and other plant uses is from the Mississippi River. Water is pumped from the main circulating water intake sump, by two vertical 750 gpm pumps, against a total dynamic head of 250 ft, into a 12,000 gal pneumatic pressure tank. The boiler feed make-up water is taken from this tank and passed through two filters prior to going through a sodium-zeolite water softener. The effluent from the softener flows to a 4000-gal treated water storage tank which maintains a constant water level through float-operated controls. The treated water is taken from the storage tank and pumped by two 25 gpm evaporator make-up pumps against a total dynamic head of 185 ft into a 600 gal pneumatic pressure tank which feeds the evaporators. One pump serves as a standby unit.

Feedwater is heated in four stages, as normal for the 11,500 kw generating units. Condensate is pumped from the condenser hot well through two low-pressure closed heaters, into the deaerating feed water heater.

Two 292 gpm boiler feed pumps deliver feedwater from the deaerating heater through a high pressure feedwater heater to the economizer. One pump serves as a standby unit. Pumps are double volute design with recirculation bypass controls.

Two 9000 gal condensate storage tanks take care of varying rates of condensate flow. A rise in deaerator water level automatically opens the overflow control valve and allows condensate to flow into the two receivers. Low water in the deaerators automatically starts a 200 gpm emergency feedwater make-up pump which transfers condensate back to the particular deaerator or deaerators until the correct level is restored. Prior to the extreme low water level condition in the deaerator, make-up is automatically admitted to the condenser hotwell from the condensate storage tanks.

Fig. 6. The forced and induced draft fans

Turbine Generators

The turbine generator is an 11,500 kw preferred standard unit. The turbine has 16 stages consisting of an impulse pressure stage, two-row velocity compounded, followed by single-row impulse pressure stages. The

four extraction points are at the 4th, 7th, 10th and 12th stages.

Two auxiliary circulating water pumps furnish cooling water to the lubricating oil cooler and the generator-air coolers. One pump serves as a standby unit. The generator-air coolers are side-mounted, of the 2-section type manufactured by Schutte and Koerting. This arrangement permits regulating flow to individual cooler section without disturbing the operation of the turbine should one cooler require maintenance.

The 12,000 sq ft surface condenser has a hotwell capacity of 575 gal. Two horizontally split centrifugal condensate pumps each handle 215 gpm against a total dynamic head of 254 ft. The condenser hotwell level is maintained by submergence control.

Circulating Water

Circulating Water. The plant location is approximately 500 ft from the Mississippi River. Circulating water is brought into and out of the plant through two 54-in. concrete conduits that extend from the river intake structure, under the highway, and into the plant. The traveling water screens and the circulating water pumps are located in the turbine room basement. Valves on each screen-pit inlet and outlet allow maintenance work to be done on either screen while water to the circulating water pumps passes through the other screen. Interconnection, with proper valving, permit water to be discharged through the downstream conduit in the summer and through the up-stream conduit in the winter when de-icing at the river intake is required. This reverse-flow arrangement will also be very effective in keeping algae growth and silt deposits in the concrete conduits to a minimum. The river at the plant has a maximum rise of 12-ft. Syphon loops on the condensers are maintained by discharging into sealing pits, from which the water overflows into terminal pits of the conduits.

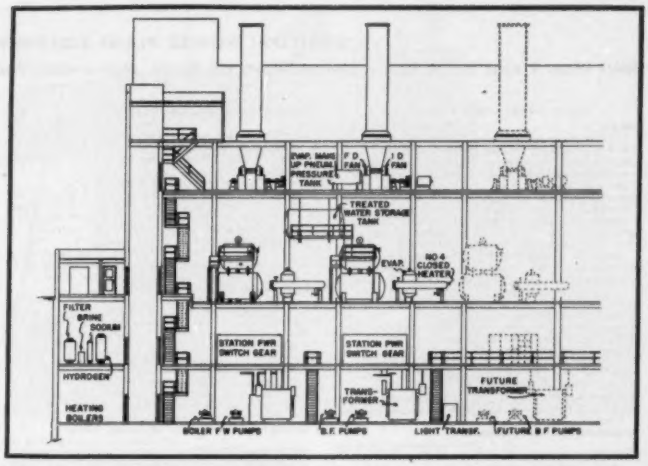


Fig. 7. Section through the boiler room showing the location of the deaerating heaters and the evaporators

Electrical Equipment

Electrical Equipment. Each generator ties directly into its step-up transformer out in the substation through shielded rubber-neoprene single conductor cables in a duct bank. A 1500-kva unit station power service transformer is also tied directly to each generator with an air blast 480-v breaker on the low voltage side. An additional 1500-kva auxiliary station power transformer out in the substation supplies an additional source of station power for starting and during emergency use. Each generator with its step-up and step-down transformer is protected with three sets of differential relays in addition to a voltage relay connected to a neutral grounding transformer. The 480-v cables feed through a duct bank from the outdoor auxiliary station power transformer to the 2000 amp bus duct within the building to the low-voltage breakers.

Station Auxiliaries

Station Auxiliaries are all electrically driven using 440 v, 3 phase, 60 cycle power. All motors 100 hp and larger are connected through 125-v d-c electrically controlled air operated breakers as starters so that these motors do not drop out of service from low voltage surges. The motor control centers and motor breaker starters are located on the operating floor between the boiler room and the turbine room, thus making them centrally located for all motor runs.

The duplex control switchboard is located in a room behind a glass enclosed wall near the center of the turbine room. This provides a quieter place for the switchboard operator who also acts as system dispatcher. Radio is used as the normal means of communication between the dispatchers' office and the five remote diesel plant stations as well as the

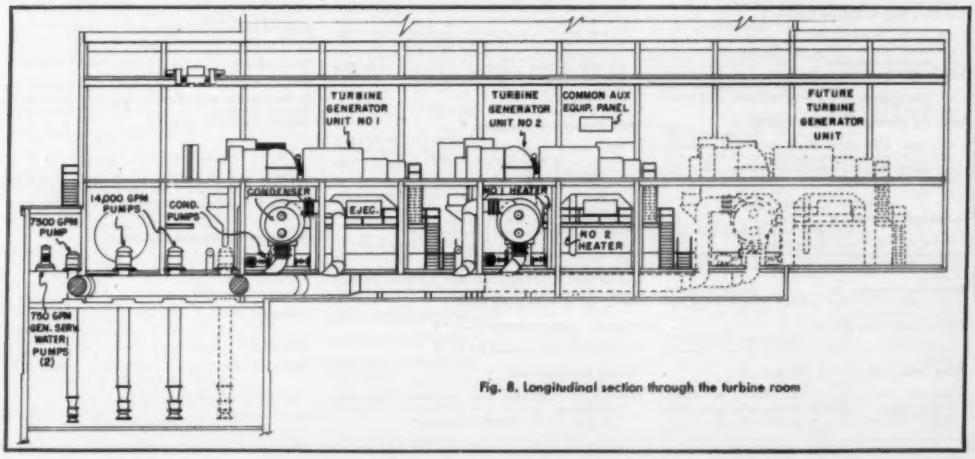


Fig. 8. Longitudinal section through the turbine room

PRINCIPAL POWER PLANT EQUIPMENT

Units Nos. 1 and 2, Elk River Steam Plant, Elk River, Minnesota, Rural Cooperative Power Association

STEAM GENERATING EQUIPMENT

Boilers, 2.....Springfield Boiler Co.
120,000 lb per hr, continuous; 135,000 lb per hr, peak; 615 psig; 830 FTT; radiant furnace, two drum; 11,000 sq ft boiler heating surface; 8000 cu ft furnace; 3536 sq ft waterwall surface, coal fired; provision for future gas and oil firing.

Superheaters, 2.....Springfield Boiler Co.
Interbank pendent type, 2 section, Swartwout spray type superheat control; 4040 sq ft heating surface.

Economizers, 2.....Springfield Boiler Co.
Continuous loop type, counter flow; 4440 sq ft; arranged for gas by-pass of two-thirds of surface.

Air Heaters, 2.....Springfield Boiler Co.
Tubular type, single pass; 13,800 sq ft surface; cold air by-pass, four air passes.

Soot Blowers.....Vulcan Soot Blower Corp.
Automatic, sequential operation, air.

Forced-Draft Fans, 2.....American Blower Corp.
223,000 lb air per hr; 8.2 in. water.

Forced-Draft Fan Drives, 2
Electric Machinery Mfg. Co.
100 hp, 1200 rpm, 440 v, 3 phase, 60 cycle, induction motors, fluid drive coupling.

Induced-Draft Fans, 2.....American Blower Corp.
254,000 lb gas per hr, 10.35 in. water, inlet box dampers.

Induced-Draft Fan Drives, 2
Electric Machinery Mfg. Co.
200 hp, 900 rpm, 440 v, 3 phase, 60 cycle, induction motors, fluid drive coupling.

Steel Stacks, 2.....Springfield Boiler Co.
Self-supporting, 30 ft high, 6 ft diameter.

Stokers, 8.....Wm. Bros. Boiler & Mfg. Co.
Model 24 super spreader, traveling grate, hydraulic grate drives, variable speed, three section grate, effective grate area 240 sq ft.

Boiler Setting.....Laclede-Christy Clay Products Co.
Studded tube tile, insulation and plastic coating finish.

Over-fire Air Blowers, 2...North American Mfg. Co.
20 hp, turbo-blower.

Cinder Return Blowers, 2..North American Mfg. Co.
5 hp, turbo-blower.

Dust Collectors, 2.....Bubar Dust Systems, Inc.
Mechanical.

Combustion Control and Instruments..Hays Corp.

Feedwater Regulation.....Northern Equipment Co.
Copes direct operated flowmatic regulator, thermostat.

Blow-off Valves.....Manning, Maxwell & Moore, Inc.

Water Column.....Reliance Gauge Column Co.

Safety Valves.....Foster Engineering Co.

POWER GENERATING EQUIPMENT

Turbine-generators, 2.....Elliott Co.
11,500 kw preferred standard, axial-flow, impulse type, 600 psig, 825 FTT, 1.5 in. Hg abs; 13,529 kva, 3 phase, 60 cycle, 13.8 kv, 3600 rpm, air-cooled generator.

Condensers, 2..Worthington Pump & Machinery Corp.
Surface type; 12,000 sq ft, two pass, spring supported, twin-element 2-stage air ejector, inter and after condensing, one evacuator.

Circulating Water Pumps, 3.....Ingersoll-Rand Co.
Single stage, axial flow, vertical, (2) 14,000 gpm and 40-ft head, (1) 7500 gpm and 35-ft head.

Circulating Water Pump Drives, 3
General Electric Co.
(2) 200 hp, 900 rpm and (1) 100 hp, 1200 rpm, 440 v, 3 phase, 60 cycle, drip-proof vertical hollow shaft motors.

Traveling Water Screens, 2.....Link-Belt Co.
28,000 gpm, 7 ft trays, galvanized steel wire screen cloth.

Traveling Water Screen Drives, 2
General Electric Co.
1 hp, 440 v, 3 phase, 60 cycle, totally-enclosed, nonventilated induction motor with Electrofluid drive unit for two speed operation.

Turbine-Oil Purification System
DeLaval Separator Co.
Oil transfer pump, rotary, 5 hp, 4.5 gpm, oil purifier, centrifuge 5 hp, 3 gpm.

Auxiliary Circulating Water Pumps, 4
Goulds Pumps, Inc.
225 gpm, 40-ft head, single stage, self-contained, horizontal, centrifugal, coupled to 5 hp, 1750 rpm, 440 v, 3 phase, 60 cycle motor, generator air-coolers and lubricating oil-coolers.

FEEDWATER EQUIPMENT

Condensate Pumps, 4
Worthington Pump & Machinery Corp.
215 gpm, 254-ft head, horizontal.

Condensate Pump Drives, 4....General Electric Co.
30 hp, 1800 rpm, 440 v, 3 phase, 60 cycle, induction motors.

Boiler Feed Pumps, 4.....Goulds Pumps, Inc.
292 gpm, 1890-ft total dynamic head, 6-stage, horizontal, centrifugal type.

Boiler Feed Pump Drives, 4
Westinghouse Electric Corp.
200 hp, 3550 rpm, 440 v, 3 phase, 60 cycle, induction motors.

Fourth-Stage Feedwater Heaters, 2
Ross Heater & Mfg. Co., Inc.
Horizontal, closed type, U-tube, 555 sq. ft. effective surface, raises 111,864 lb per hr water from 285 to 345.4 F, 300 psig shell pressure, 900 psig tube pressure.

Tenth-Stage Feedwater Heaters, 2
Ross Heater & Mfg. Co., Inc.
Vertical, closed type, U-tube, 368 sq ft effective surface, raises 90,034 lb per hr water from 172.7 to 216.8 F, 150 psig shell pressure, 150 psig tube pressure.

Twelfth-Stage Feedwater Heaters, 2
Ross Heater & Mfg. Co., Inc.
Vertical, closed type, U-tube, 546 sq ft effective surface, raises 84,981 lb per hr water from 95.2 to 172.1 F, 150 psig shell pressure, 150 psig tube pressure.

Twelfth-Stage Heater Drain Pumps, 2
Worthington Pump & Machinery Corp.
30 gpm, 220-ft head, horizontal, close coupled to 10 hp, 1800 rpm, 440 v, 3 phase, 60 cycle motor.

Deaerating Feedwater Heaters, 2
Worthington Pump & Machinery Corp.
Horizontal-double shell-tray type; 133,000 lb per hr water flow, 10 minute storage capacity, 45 psig shell pressure, surface-type vent condenser.

Evaporators, 2
Condenser Service & Engineering Co., Inc.
Vertical, submerged tube bundle; 2000 lb per hr vapor at 58.6 psia when supplied with 2419 lb per hr steam at 135.4 psia, 1303 Btu per lb, 100 psig shell pressure, 300 psig tube pressure, 70.8 sq ft effective heating surface, 12 sq ft disengaging surface.

Emergency Feedwater Make-up Pump, 1
Allis-Chalmers Manufacturing Co.
200 gpm, 160-ft head, single stage, self-contained, horizontal, centrifugal, coupled to 15 hp 3500 rpm, 440 v, 3 phase, 60 cycle motor, automatic start-stop, deaerating heater low water level float-operated.

Water Softener, 2.....Refinite Sales Co.
Duplex sodium zeolite unit; 32,000 gal per day, pretreatment to evaporators.

Raw Water Filters, 2.....McKays Co.
Vertical type, 28 gpm filtering capacity each filter 7 sq ft effective filtering area, water pressure. 100 psig.

Evaporator Make-Up Pumps, 2..Goulds Pumps, Inc.
25 gpm, 185-ft head, single stage, self-contained, horizontal, centrifugal, coupled to 5 hp 3550 rpm, 440 v, 3 phase, 60 cycle motor, automatic start-stop, pneumatic pressure tank pressure switch control.

PIPING

Piping Fabricator and Erector
Fuel Economy Engineering Co.

High and Low Pressure Valves
- Crane Co.
- The Williams Gauge Co.
- Hancock Valve Co.

Extraction Bleeder Check Valves
Atwood & Morrill Co.

Circulating Water Butterfly Valves.Henry Pratt Co.

Control Valves.....Fisher Governor Co.

Miscellaneous Piping Equipment
- U. S. Rubber Co.
- Grinnell Co.
- Elliott Co.
- Armstrong Machine Works
- Chicago Metal Hose Corp.

COAL AND ASH HANDLING EQUIPMENT

Coal Handling System.....Beaumont Birch Co.
100 tons per hr Southern Illinois coal or North Dakota Lignite, car unloading shed, car shakeout, car puller, reciprocating plate feeders, collecting belt conveyor, elevating conveyor, truck hopper, vibrating screen, coal crusher, distributing conveyor, belt conveyor tripper, coal elevator, reclaiming hopper, two boiler room coal bunkers 300 tons each, four 200 lb dump 30,000 lb per hr coal scales, chutes, gates.

Coal Storage System.....Beaumont Birch Co.
Hoist house, 1 cu yd scraper; 22,000 ton coal storage.

Ash Handling System.....Beaumont Birch Co.
20 tons per hr, ash separator, air washer, conveying lines, ash hoppers, 30 tons per hr rotary drum type dustless unloader, 5 hp gear drive, vitrified glazed tile ash silo 16 ft diameter 32 ft 4 in. high, grass capacity 210 tons, live storage 150 tons, filter vent.

ELECTRICAL EQUIPMENT

Main Power Transformers, 2
Westinghouse Electric Corp.
Three phase 10,000/12,500 kva self-cooled/forced-air-cooled 69 kv ground wye—13.2 kv delta, 60 cycle oil-immersed.

Outdoor Station Service Transformer, 1
Kuhlman Electric Co.
Three phase 1500 kva self-cooled 69 kv ground wye—480 v delta, 60 cycle oil immersed.

Indoor Station Service Transformers, 2
Pennsylvania Transformer Co.
Three phase 1500 kva, self-cooled, 13.8 kv/480 v, 60 cycle delta-delta, askarel filled.

Substation, 3 Transformer and 4 Feeder Bays
Railroad & Industrial Engineering Co.

Oil Circuit Breakers 69 kv, 7
Westinghouse Electric Corp.

Current Transformers 69 kv, 12
Westinghouse Electric Corp.

Potential Transformers 69 kv, 7
Westinghouse Electric Corp.

Circuit Breakers—Air, 5.....Roller Smith
2000 amp, 480 v, 25,000 mv, 60 cycle.

Generator Excitation and Lightning Protection Switchgear.....Kirkhof Electric Co.
2 cubicles with Westinghouse equipment.

Generator Neutral Cubicles, 2..Kirkhof Electric Co.

Duplex Control Switchboard....Kirkhof Electric Co.

Generator Voltage Regulators
Allis-Chalmers Manufacturing Co.

Instruments, Meters and Relays
Westinghouse Electric Corp.

Line and Ground Relays.....General Electric Co.

Recording Instruments.....Leeds & Northrup Co.

Annunciator.....Edwards and Co., Inc.

Lighting Transformers, 3....Wagner Electric Corp.
4800/120/240 v, single phase.

Low Voltage Air Breakers, 480 v
General Electric Co.

Motor Control Centers, 480 v..Trumbull Electric Co.

Lighting Panels.....Trumbull Electric Co.

Storage Battery, 125 v.....Exide

Intercommunication Phone System
Kellogg Switchboard & Supply Co.

OTHER EQUIPMENT

Plant Air Compressor, 1.....Ingersoll-Rand Co.
2-stage, tank-mounted, 32.7 cfm, 150 psig, 540 rpm 80 gal receiver.

Plant Air Compressor Drive, 1
Westinghouse Electric Corp.
10 hp, 1750 rpm, 440 v, 3 phase, 60 cycle motor.

Seal Blower Air Compressors, 2.Ingersoll-Rand Co.
2-stage tandem double acting, horizontal, 264 cfm, 500 psig, after-coolers, 250 rpm.

Seal Blower Air Compressor Drives, 2
Electric Machinery Mfg. Co.
100 hp, 1200 rpm, 440 v, 3 phase, 60 cycle motors.

Air Receivers, 2—410 cu ft each
Wm. Bros. Boiler & Mfg. Co.

Control Air Compressors, 2.....Ingersoll-Rand Co.
Single stage, double-acting, horizontal, 58 cfm, 100 psig, after-coolers, 400 rpm, carbon rings.

Control Air Compressor Drives, 2
General Electric Co.
15 hp, 1800 Rpm, 440 v, 3 phase, 60 cycle motors.

Air Receiver, 96 cu ft.....Ingersoll-Rand Co.

Miscellaneous Tanks....Wm. Bros. Boiler & Mfg. Co.

Evaporator Chemical Feed Pumps, 2. Milton Roy Co.
Simplex, 3 gph adjustable, 80 psig discharge pressure, 200 gal solution tank and agitator.

Boiler Feed Pump Chemical Feed Pumps, 2
Milton Roy Co.
Simplex, 5 gph adjustable, 80 psig discharge pressure, 300 gal solution tank and agitator.

Boiler Steam Drum Chemical Feed Pumps, 2
Milton Roy Co.
Simplex, 3 gph adjustable, 710 psig discharge pressure, 300 gal solution tank and agitator.

General Service Water Pumps, 2
Fairbanks, Morse & Co.
750 gpm, 260 ft head, 6-stage, semi-open impeller, vertical, close-coupled turbine pump.

General Service Water Pump Drives, 2
Fairbanks, Morse & Co.
60 hp, 1750 rpm, 440 v, 3 phase, 60 cycle vertical hollow shaft induction motor.

Domestic Well Pump, 1...Peerless Pump Division, Inc.
100 gpm, 139-ft head, horizontal, centrifugal, close-coupled to 7½ hp, 3450 rpm, 440 v, 3 phase, 60 cycle motor.

Domestic Well.....Keys Well Drilling Co.
8-in. casing, 277 ft deep.

Turbine Room Crane..Manning, Maxwell & Moore, Inc.
Traveling overhead type, 50 ton main hoist, 5 ton auxiliary hoist, 39-ft span, 176-ft crane runway.

Heating Boilers for Plant & Office Building, 2
Spencer Heater Division
Fire-box type, oil-fired, 15 psig working pressure, 8500 sq ft of EDR.

Heating Boiler Oil Burners, 2...Ray Oil Burner Co.
Horizontal, rotary type, Minneapolis-Honeywell controls.

Air Conditioning.....Massachusetts Fan Co.

Ventilation.....DeBothezat Fans Division

Unit Heaters
- Trane Company
- L. J. Wing Manufacturing Co.

Radiation, Fin-Tube Type.....Vulcan Radiator Co.

Freight Elevator.....Lee-Hoff Manufacturing Co.

Circulating Water Conduits
Elk River Concrete Products Co.

PRIME CONTRACTORS

Building.....Steenberg Construction Co.
St. Paul, Minnesota

Piping & Auxiliary Equipment and Turbine Erection.....Fuel Economy Engineering Co.
St. Paul, Minnesota

Steam Generating Unit Erection
Springfield Boiler Co.
Springfield, Illinois

Coal and Ash Handling Equipment Erection
Beaumont Birch Co.
Philadelphia, Pa.

Painting
- C. A. Pierson Co.
- Twin City Sandblast
Minneapolis, Minnesota

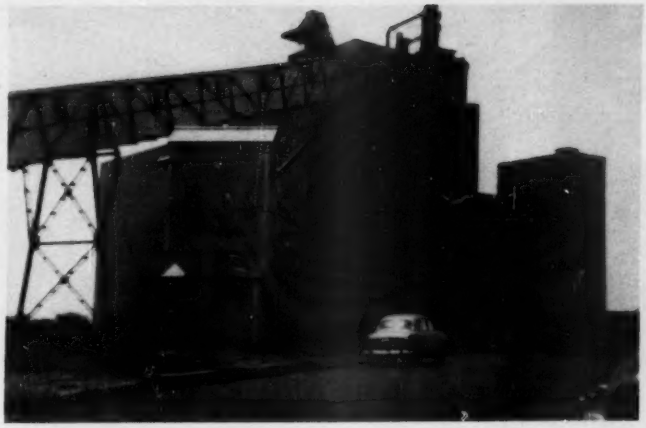
Electrical.....Kehne Electric Co.
St. Paul, Minnesota

Signs.....Meyers Outdoor Advertising, Inc.
Minneapolis, Minnesota

ENGINEERS AND DESIGNERS

Ralph D. Thomas & Associates, Inc.
Minneapolis, Minnesota

Fig. 9 (Right). An outdoor view showing the coal and ash handling equipment



transmission line construction trucks.

Since the power cooperative's transmission system will not be converted to 69 kv until 1952, the three power transformers in the substation were ordered with high side delta-wye terminal boards and connected 37.8/13.2-kv delta-delta to permit operation of the system at 34.5 kv during the interim period. This meant that the generators are required to operate during this interim at about 10 per cent below normal voltage, which has been accomplished with success. The substation is designed with a transfer bus so that during the change over period to the higher voltage, it will be possible to operate one power transformer at 34.5 kv and the other at 69 kv.

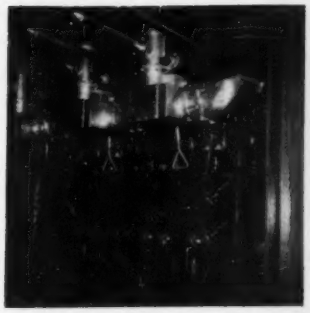


Fig. 10. Rear view of one of the boilers showing the ash lines, cinder return lines, blow-off lines

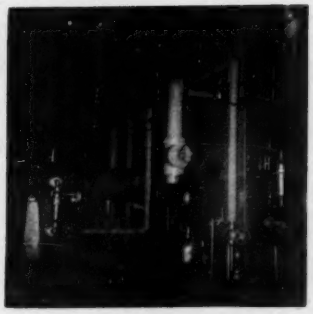


Fig. 11. View showing the evaporator and high pressure closed feedwater heater

All equipment is completely housed. The exterior building walls are constructed of load bearing tile, faced with unglazed buff hard-burned brick; except the front wall facing the highway, the main portion of which is built with insulating concrete panels with glass inserts. These provide an attractive visual effect at night from interior lighting. The reception room and entrance lobby portion is finished with large glass panels and includes an entrance canopy. The plant is provided with wall louvers for ventilating and combustion air and with power-driven roof ventilators. The roof is constructed of precast, lightweight concrete slabs with spun-glass block insulation and standard pitch and gravel roofing. All office spaces are air-conditioned.

The turbine-room operating floor is finished with red quarry-tile and the walls with light-colored glazed brick. Interior walls and equipment are painted in attractive colors. All piping is painted with standard code colors. Ample working space has been provided around all equipment for operation and maintenance.

A separate steam heating plant serves the power plant and the office and warehouse building located at the rear. Water for domestic use in both buildings is supplied from a flowing well through a hydro-pneumatic pumping system.

The plant was designed by Ralph D. Thomas and Associates, Inc., of Minneapolis, Minnesota. Architectural design was by their associates, Thorshov and Cerny, Inc.

Total construction cost, including land, legal and engineering, is approximately $4,500,000. This includes some $800,000 in building and other provisions for the future 15,000-kw unit. The net cost per kilowatt of present capacity is $160, and will be close to this figure for the ultimate 38,000-kw station.

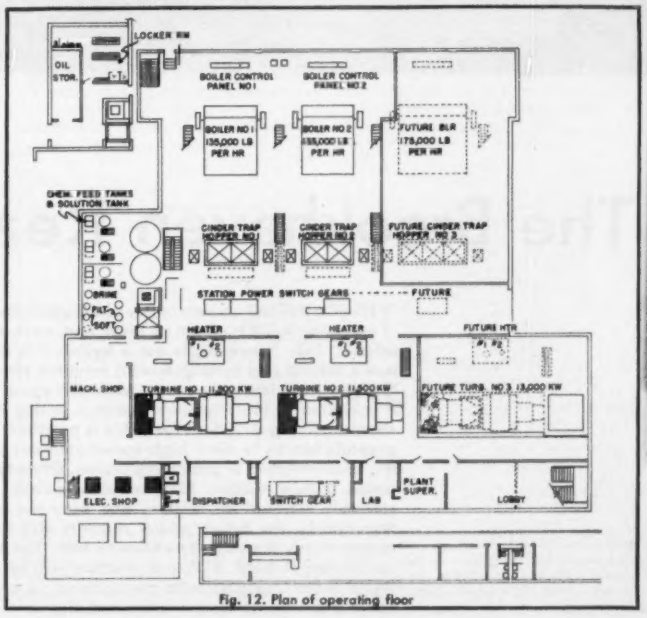
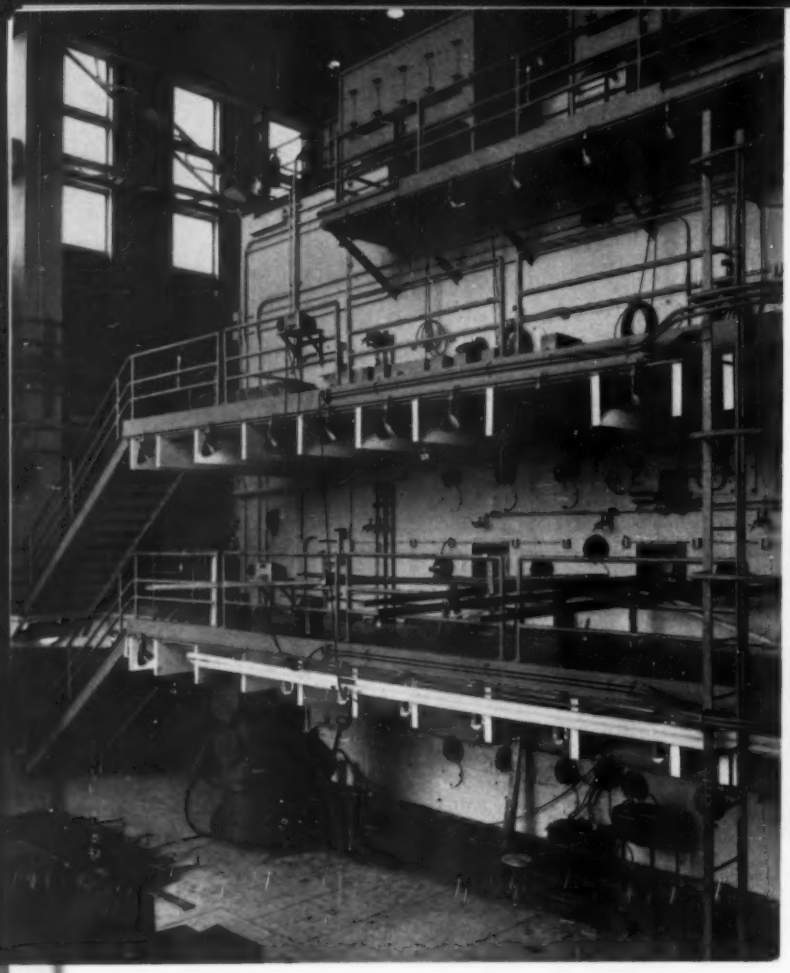


Fig. 12. Plan of operating floor



What

The Brookhaven Reactor

THE EQUIPMENT shown in this photograph looks something like the side of a modern steam boiler. It is about as large and, as in a boiler furnace, heat is generated in its interior. This, however, is not a boiler; it is the Brookhaven nuclear reactor, the nation's largest and most powerful research reactor. It was designed primarily to study the effects of intense neutron radiation upon various materials. Basically, however, it is similar to other types of reactors in that it operates by virtue of a nuclear chain reaction, using U-235 as *fuel*. This is a carbon moderator type of reactor in that it uses graphite blocks to slow high-speed neutrons down to thermal velocities, where they are most effective in producing fission. Other types of reactors are shown on following pages. Future reactors for generating power, while at the same time producing fissionable material for military use, may not look greatly different from this reactor. Necessarily, the future power reactors will have to operate at considerably higher temperatures than the Brookhaven unit. The latter is cooled by blowing tons of air per second through it. Power reactors will be *cooled* by the use of water or perhaps liquid metal coolants with the systems so arranged that the heat abstracted in the coolant can be utilized in a thermal engine — a steam or gas turbine.

About the Atomic Power Plant?

The commercial production of power from nuclear energy is probably closer than many people suspect. Recent reports indicate considerable progress in the development of mobile nuclear power plants for military use. This article discusses the relation of this military work to the development of plants for stationary use and also the economic and thermodynamic aspects of atomic power plant development, including operating factors involved in both high- and low-temperature plants

By ANDREW W. KRAMER

Editor, POWER ENGINEERING

SINCE the first wave of excitement and public interest in the development of atomic energy died down a few years ago, the conservatives have been basking contentedly in the assurance that their hastily, though perhaps unwisely, formed conclusions concerning the relative remoteness of atomic power were entirely correct. They predicted that the practical development of atomic power from nuclear energy was anywhere between 20 and 50 years off, and that for the present, power engineers need concern themselves little with the subject of nuclear energy. They pointed out that even if the technical difficulties could be overcome, the economic aspects of atomic power generation were such that it could not compete with conventional fuel-fired power plants. The more one penetrated engineering circles, the more firmly this attitude prevailed.

To one familiar with the engineering type of mind, this conservative attitude is quite understandable. Engineers deal with facts and figures, with things that can actually be done — not with dreams and fancies, however attractive the latter may appear. They are not prone to stick their necks out, particularly on matters somewhat removed from their normal spheres of activity. These remarks apply to engineers as a class; individually, there are always notable exceptions. In this instance there were those with enough foresight and with enough sense of history to understand that so stupendous a force as nuclear energy would rush ahead beyond all normal expectations, especially under the stimulus of military urgency. They possessed the imagination to know that obstacles both practical and economic have a way of disappearing when the pressures are great enough.

Recent news about atomic-powered submarines and aircraft indicates that atomic power for general industrial use may be closer than engineers, generally, have been willing to admit. All nuclear energy development is, of course, highly secret and the fragments released to the public by the Atomic Energy Commission can only serve to indicate some measure of the progress that is being made. The mere fact, however, of atomic powered submarines and atomic powered aircraft actually under construction, indicates that the experimental work on the reactors which are to power these submarines and airplanes has been sufficiently successful to warrant construction of the hulls and planes. The Air Force announcements indicate that experiments with atomic engines have progressed far enough to justify scientists' predictions two years ago, that atomic aircraft are feasible. The General Electric Company's jet engine division in Lockland, O. has an Air Force contract to develop an atomic engine for the plane. An atomic power submarine has been under construction by the Electric Boat Co. at Groton, Conn., for some time.

Now, it should be obvious to anybody that if it proves possible to construct a successful atomic power plant to drive a submarine, then it should also be possible to build a stationary plant producing power by means of a nuclear reactor. And, from various bits of news that have been released recently, the actual design and construction of such plants does not seem to be very far off. In a recent address at the third annual Oak Ridge Summer Symposium, Dr. C. G. Suits, Director of Research for General Electric, said that the production of both power and plutonium in a specially designed reactor now seems feasible, and he predicted greatest utilization of nuclear power in such industries as aluminum and iron and steel. Cost estimates offered by Dr. Suits were based on the relatively early development of by-product power with a military subsidy.

In thinking about such combination nuclear power plants, however, we must not be influenced too much by conventional power plant practice. Even assuming that these plants will be steam plants using steam turbine driven electric generators, they may be quite different from the high-pressure, high-temperature plants built in recent years.

In directing attention to the possibility of an atomic power plant for industrial use based on the work in progress for military purposes, an editorial in a contemporary journal[1] stated recently: "Nowhere along the path of the discussion of atomic power has it been established whether the reactors can be safely worked and controlled at temperatures that will

[1] *Electrical World*, September 24, 1951, p. 70.

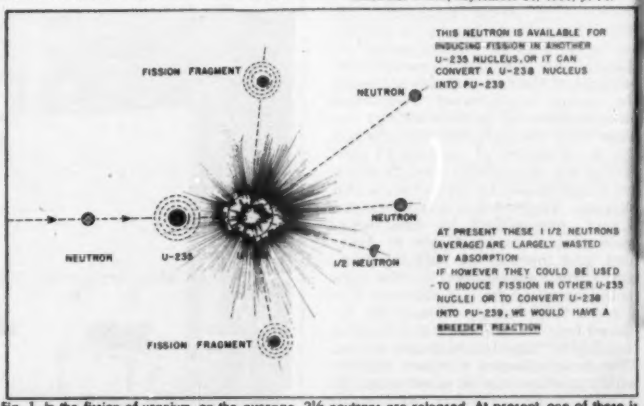

THIS NEUTRON IS AVAILABLE FOR INDUCING FISSION IN ANOTHER U-235 NUCLEUS, OR IT CAN CONVERT A U-238 NUCLEUS INTO PU-239
FISSION FRAGMENT
NEUTRON
NEUTRON
U-235
1/2 NEUTRON
AT PRESENT THESE 1 1/2 NEUTRONS (AVERAGE) ARE LARGELY WASTED BY ABSORPTION IF HOWEVER THEY COULD BE USED TO INDUCE FISSION IN OTHER U-235 NUCLEI OR TO CONVERT U-238 INTO PU-239, WE WOULD HAVE A BREEDER REACTION
FISSION FRAGMENT

Fig. 1. In the fission of uranium, on the average, 2½ neutrons are released. At present, one of these is needed to convert a U-238 nucleus into a plutonium nucleus while the remaining 1½ neutrons are largely wasted through absorption. If the efficiency of nuclear reactors can be improved so that the remaining 1½ neutrons could also be utilized either for the production of plutonium or further fission of U-235, we would have a breeder reactor. A ½ neutron of course is a statistical conception

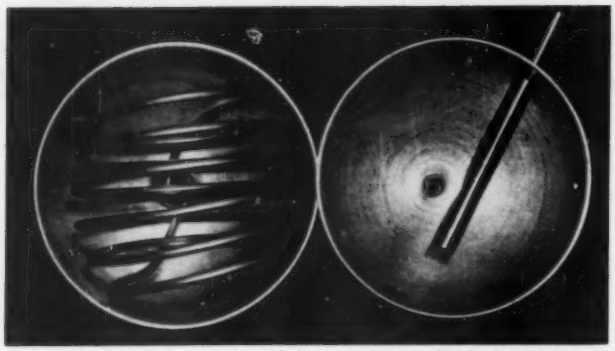


Fig. 2. A nuclear reactor can be as simple as this. This is an inside view of the Los Alamos homogeneous reactor. (The Water Boiler) It consists of a spherical container to hold an enriched uranium fuel solution. The halves are made of stainless steel one foot in diameter. Inside, is a 6-turn cooling coil through which water is circulated to carry off the heat generated in the reaction. The one-inch straight tube, called the glory hole, will be welded horizontally through the sphere to permit materials to be placed in the region of highest neutron flux. The normal loading is about 1.9 lb of U-235. About 50 gal of water per hour is pumped through the cooling system which is sufficient to permit year-round operation at 6 kilowatts

result in steam at *temperatures and pressures that are representative of today's electric system power plants — say 1200 to 2000 psi, and 900 to 1000 F.*" (The italics are ours.)

Continuing, the editorial introduces the economic aspects; "Putting it in other terms, even if it proves feasible and practicable to derive firm and dependable power from nuclear reaction, will it be at thermodynamic levels that typify today's thermal efficiencies or must it compete economically by carrying the disadvantage of the lower, less efficient levels?"

In the light of even the meager information released officially, these questions concerning temperatures, pressures, and economics seem irrelevant. There is no need to limit our thinking about non-military nuclear energy development in terms of conventional power practice, either as regards heat and pressure levels, or economics. As pointed out by Alvin Weinberg, of Oak Ridge National Laboratory, in an address before the Institute of Radio Engineers last March, a nuclear reactor is unique among sources of thermal energy in that the rate of energy release is independent of the temperature at which the energy is generated. This basic independence of nuclear energy release from temperature has allowed the development of reactors to proceed along two parallel threads which are characterized by temperature and purpose. There is a low-temperature thread, exemplified by the large-scale plutonium producers at Hanford, and there is the high-temperature thread exemplified by the projected naval or aircraft reactors. For a given total energy release, the required heat transfer surface is smaller the higher the temperature range. This means that a compact reactor which produces useful power must be a high-temperature one, and quite apart from questions of thermal efficiency, this is the reason why the military mobile reactors belong to the high-temperature class.

Where reactor size is unimportant, however, there is good incentive to operate at low temperature, for two reasons: first, because at low temperature, materials are generally more adequate, and secondly, because the very best moderator, heavy water, is inherently a low-temperature material.

In a conventional steam power plant where the prime motivation is fuel economy, advantages in material performance which accrue from low pressure and temperature are more than balanced by the thermodynamic or fuel-efficiency advantage of high temperature. In a nuclear power plant, on the other hand, where fuel efficiency is secondary to material performance, the incentive to run at high temperature is much smaller.

It is very likely, therefore, that the future nuclear power plant for commercial power production will involve a rather low-temperature, low-thermal efficiency system which will combine the long-term objectives of fissionable material and power production, and in which all compromises will be made in the interest of overall low cost.

At the present time the plant at Hanford is producing plutonium from U-235. In the process enormous quantities of heat are produced at a low temperature level, a level sufficient to heat the large quantity of cooling water used only a few degrees. This heat which is the equivalent of well over a hundred thousand kilowatts, is wasted. The reactors at Hanford are designed only for plutonium production.

As already indicated, however, from a nuclear standpoint, there is no reason why reactors producing plutonium should not be run at a high temperature level — it would in no way interfere with the efficiency of plutonium production. Thus, by raising the operating temperature level to a point so that relatively low-pressure, low-temperature steam would be produced by the coolant, we would attain both power production and fissionable material production in the same reactor. By not trying to attain too high a temperature, many of the material difficulties which beset operation at temperatures around 1000 F would disappear.

The fissionable material (Plutonium or U-233) produced in such combination power and fissionable material reactors will presumably be used for military weapons or for high temperature, high efficiency mobile systems. Since such fissionable material will be needed in ever increasing quantities, it is logical to suppose that in the foreseeable future, great emphasis will be put on the development of the low-temperature-fissionable-material power reactors.

There have been many attempts to calculate the economics of nuclear reactor power plants and to compare

(*Continued on page 132*)

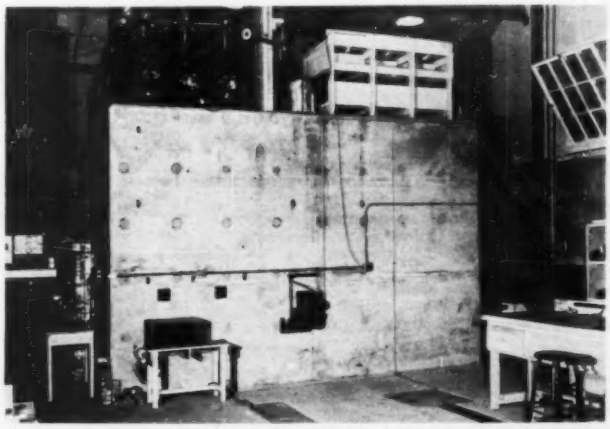


Fig. 3. This is a view of the complete reactor at Los Alamos. This contains the spherical reactor shown in Fig. 2. The ports in the concrete shield permit experiments in which various types of materials may be placed in the intense neutron flux inside the shielding

Graph Your Deaerator Heat Balance

Here is a simple, graphical method of determining the performance of a deaerating heater for other than *rated* conditions. By simply drawing a basic triangle and calibrating it in terms of make-up, condensate, and steam, all calculations are reduced to a minimum. It is applicable to any direct-contact feedwater heater

By FREDRIC R. ALEX Mechanical Engineer, Boddy-Benjamin Associates, Inc., Detroit, Michigan

ESTABLISHING heat balances of low pressure steam systems in power and steam generating plants with direct contact deaerator heaters often necessitates a check of the heater performance for other than rated conditions.

Since the flow rates of make-up water, condensate and steam entering a deaerator heater vary independently of each other in their contribution to the heat exchange process, a considerable number of similar computations have to be carried out in an attempt to balance the compounded heat absorption capacity of the make-up water and the condensate with the heat available from the steam.

The method to be described in the following has been devised with the intention of eliminating the repetition of these computations. The method is almost entirely graphical and thus independent of formulae. It is applicable to any feedwater heater of the direct contact type. It is time-saving and yields sufficiently accurate values of the desired flow rates of make-up water, condensate and steam.

The work to be done is reduced to a few introductory calculations, the drawing and calibrating of the basic *Heater State Triangle*, and the drawing of reference lines for the three mass-flows.

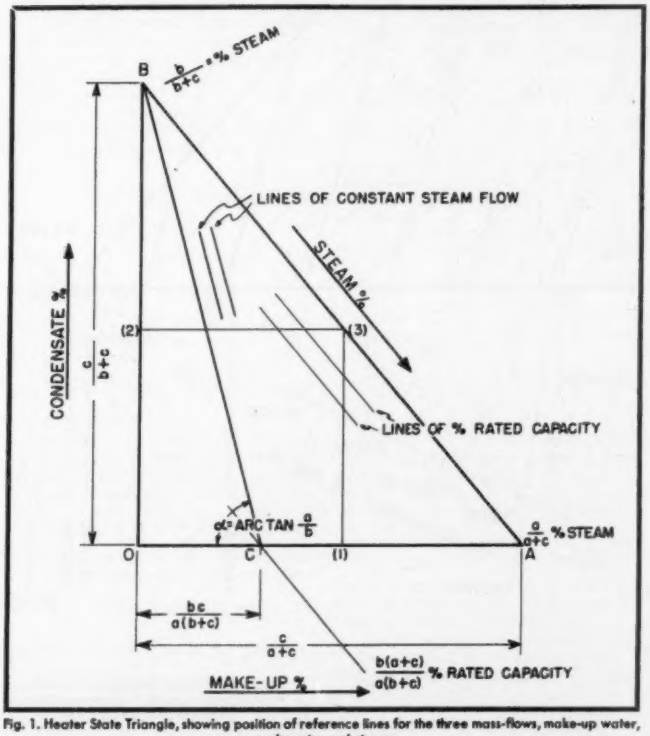


Fig. 1. Heater State Triangle, showing position of reference lines for the three mass-flows, make-up water, condensate, and steam

With constant water level and heater pressure at saturation temperature provided, economic heater operation requires that

1. The sum of make-up water, condensate and steam, admitted into the heater in unit time equals the amount of feedwater leaving the heater in unit time, and
2. The amount of heat released by the steam in unit time equals the amount of heat absorbed by make-up water and condensate in unit time.

Expressing the second requirement in the form of an equation, the heat balance of the feedwater heater for one pound of feedwater may be written as:

$$ax + by = c\,(1 - x - y) \quad (1)$$

The symbols used have the following significances:

a. Heat absorbed by one pound of make-up water, Btu per lb
b. Heat absorbed by one pound of condensate, Btu per lb
c. Heat released by one pound of steam, Btu per lb
k. Rated capacity of the deaerator heater, lb per hr
l. Make-up water flow in lb per hr, based on the assumption that rated capacity is developed by steam and make-up water only
m. Condensate flow in lb per hr, based on the assumption that rated capacity is developed by steam and condensate only
x, y. Percentage of make-up and condensate, respectively, in one pound of feedwater.
S_{min} S_{max} Minimum and maximum steam flow at rated capacity, lb per hr.

Rearranging the equation (1) the basic heater equation becomes:

$$\frac{x}{\frac{c}{a+c}} + \frac{y}{\frac{c}{b+c}} = 1 \quad (2)$$

Equation (2) can be portrayed as a straight line in a rectangular coordinate system as shown in Fig. 1. The straight line intersects the x-axis at the point A, at the distance $\frac{c}{a+c}$ from the origin, and the y-axis at the

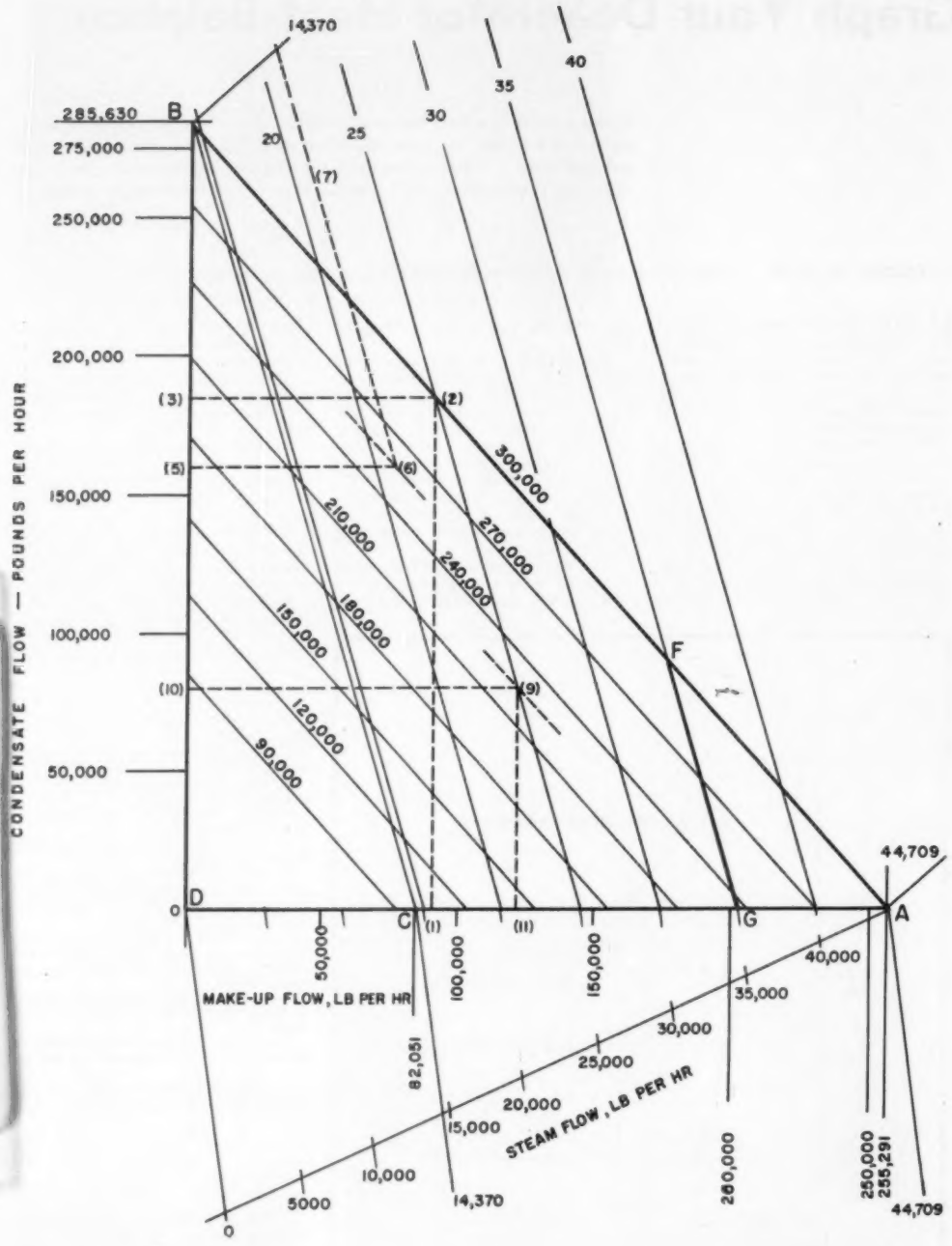


Fig. 2. An example showing how the Heater State Triangle is used in determining the performance of a typical heater

point B, at the distance $\frac{c}{b+c}$ from the origin, both values being obviously less than unity.

The value $\frac{c}{a+c}$ represents the maximum percentage of make-up water at rated heater capacity with zero condensate flow, and the value $\frac{c}{b+c}$ represents the maximum percentage of condensate at rated heater capacity with zero make-up water flow.

The percentage of steam in the rated heater capacity for the boundary conditions in A and B may be obtained by deducting the values for $\frac{c}{b+c}$ and $\frac{c}{a+c}$ from unity.

These percentages are:

$$1 - \frac{c}{b+c} = \frac{b}{b+c} = \frac{k-m}{k}$$

being the percentage of steam to be admitted at rated capacity with zero make-up flow, in lb per lb, and for the heater state at B.

$$1 - \frac{c}{a+c} = \frac{a}{a+c} = \frac{k-l}{k}$$

being the percentage of steam to be admitted at rated capacity with zero condensate flow, in lb per lb, for the heater state at A

The last values are the minimum and maximum percentages of steam to be admitted into the heater when rated capacity has to be developed.

Multiplying the ratios determined in the foregoing by the rated heater capacity, k, the effective mass flows participating in the heat exchange process at rated heater capacity may be obtained as:

$l = \frac{c}{a+c}$ the maximum make-up water flow in lb per hr

$m = k\frac{c}{b+c}$ the maximum condensate flow in lb per hr

$S_{min} = \frac{kb}{b+c}$ the minimum steam flow in lb per hr

$S_{max} = \frac{ka}{a+c}$ the maximum steam flow in lb per hr

The "Heater State Triangle" in Fig. 1, has been labelled according to the text. The distances OA and OB have to be calibrated from zero to $\frac{c}{a+c}$, and from zero to $\frac{c}{b+c}$, respectively, and the distance BA has to be calibrated in the direction of the increasing steam flow from $\frac{b}{b+c}$ at the point B, to $\frac{a}{a+c}$ at the point A.

The "Heater State Triangle," Fig. 1, as the graphical representation of equation (2), portrays the functional relations of the percentages of the three fluids at rated capacity only.

The values of two of the dependent variables, for instance make-up and condensate, related to any value of the independent variable, for instance the steam available, and all expressed in per cents of the rated capacity, can now be read from the three scales, being the abscissa (1), the ordinate (2) and the coordinate of the point (3) on the BA-scale.

For any fractional heater capacity correlated values of the make-up, condensate and steam may be obtained by multiplying the values, read from Fig. 1, by the ratio of specified capacity to rated heater capacity.

Two more families of reference lines have to be determined in order to make the heater state triangle completely suitable for the analysis of any heater. They are the following:

1. The lines of percentage of rated capacity, obtained by calibration of the perpendicular distance between the origin and the hypothenuse from zero to 100 per cent; and by drawing the reference lines parallel to AB through the various calibration points of the perpendicular line. The usefulness of these reference lines is evident when labelled for mass-flows in lb per hr as demonstrated in the example at the end of this article

2. The lines of constant steam flow, portraying the heater conditions for constant amounts of available steam, and obtained by drawing reference lines parallel to BC for any specified ratio of steam flow at rated capacity.

In order to determine the abscissa of the point C, steam admitted in the percentage of $\frac{b}{b+c}$, and zero condensate flow shall be assumed, and the make-up, capable of absorption of the heat released by the steam calculated.

It is obvious that the abscissa of C equals the value of maximum make-up percentage $\frac{c}{a+c}$, multiplied by the ratio of minimum to maximum steam percentage at rated capacity. Therefore

$$OC = \frac{c}{a+c} \times \frac{b}{b+c} \times \frac{a+c}{a} = \frac{bc}{a(b+c)}$$

and the angle of these reference lines with the x-axis will be

$$\alpha = \text{arc tan}\ \frac{c}{b+c} \times \frac{a(b+c)}{bc} = \text{arc tan}\ \frac{a}{b}$$

being a function of the quotient of the heat absorption capacities of make-up and condensate only.

The percentage of rated capacity to be expected at operating point C may be obtained from the triangle OBC as

$$\%\ \text{of rated capacity} = \frac{b}{a}\left(\frac{a+c}{b+c}\right)$$

The functional relations investigated in the foregoing permit the analysis of the behavior of any deaerator heater. The system of graduating the triangle scales in flow percentages may be abandoned, and scales and reference lines may be graduated and labelled for mass flows in lb per hr, thus rendering the heater triangle directly applicable to a specific heater.

Example of Application

In order to demonstrate the proper procedure for an actual application, the analysis of a 300,000 lb per hr deaerator heater with make-up and condensate admission will be given as an example.

The following data have been chosen as typical:

Deaerator heater operating pressure.....5.3 psig
k, rated capacity..300,000 lb per hr
Temperature of the feedwater.228 F
Feedwater enthalpy.196.2 Btu per lb
Make-up water temperature...60 F
Make-up water enthalpy .....28.06 Btu per lb
Condensate temperature.....180 F
Condensate enthalpy.....147.9 Btu per lb *

Referring to Fig. 2, proceed as follows:

Step 1. Compute the heat absorption capacity of make-up and condensate, a and b, respectively, and the heat release from the steam, c.

a = 196.2 − 28.06 = 168.14 Btu per lb

b = 196.2 − 147.9 = 48.3 Btu per lb

c = 1156.3 − 196.2 = 960.1 Btu per lb

Step 2. Compute the maximum flow percentage of make-up and condensate at rated heater capacity $\frac{c}{a+c}$, and $\frac{c}{b+c}$, respectively

$$\frac{c}{a+c} = \frac{960.1}{168.1+960.1} = 0.85097$$

$$\frac{c}{b+c} = \frac{960.1}{48.3+960.1} = 0.9521$$

and obtain the maximum make-up and condensate flow by multiplying the above values by k, the rated capacity:

$k\frac{c}{a+c} = 300{,}000 \times 0.85097 =$ 255,291 max make-up flow, lb per hr

$k\frac{c}{b+c} = 300{,}000 \times 0.9521 =$ 285,630 max. condensate flow, lb per hr

and draw the last values calculated, in proper scale, in a rectangular coordinate system, lines OA and OB in Fig. 2.

(*Continued on page 130*)

* Values taken from: Thermodynamic Properties of Steam. J. H. Keenan and F. G. Keyes. John Wiley and Sons, Publishers.

Packaging Improves A-C Generator Control

BY W. P. BURT Switchgear Division, General Electric Co.

Bigger and more exacting demands on a-c generator excitation systems have brought about an increase in the number and complexity of components. In this case, putting your eggs in one basket is good advice—i.e.—put all the components in an engineered "package". This eliminates divided responsibility and is advantageous from both the operational and the power room layout standpoints

Fig. 1. Front view of amplidyne voltage regulator excitation equipment showing complete equipment in one enclosure

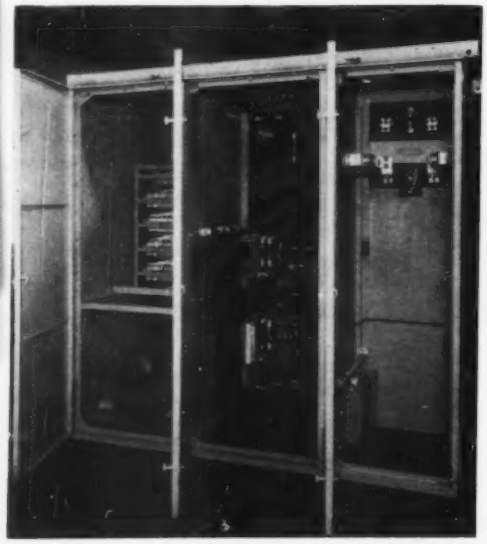


Fig. 2. Rear view of amplidyne voltage regulator excitation equipment shown in Fig. 1 with the field circuit breaker in the right end unit, voltage regulating equipment and auxiliaries in the center unit and the exciter field rheostat and amplidyne m-g set in the left end unit

IN RECENT YEARS, many a-c generators have been provided with excitation systems and regulating equipment of greater precision, speed, range, and flexibility of operation. These improvements were necessary because of the more exacting operating requirements.

As a result, there has been an increase in the number of components. Typical of these are: the field circuit breaker and discharge resistor; motor operated exciter field rheostat; voltage regulator equipment and auxiliaries. Also, it has been found advantageous to house all of these elements in a single structure.

Such unit equipments have benefited the users because the engineering is completely co-ordinated and the disadvantages of divided responsibility are eliminated. Also, the station layout is simplified and the installation costs reduced by the elimination of conduit between components.

Excitation equipment for a large turbine-generator is shown in Figs. 1 and 2. This type of equipment is generally used for turbine generators rated 25,000 kva and larger, although it has also been used for smaller machines and can be applied to hydro-generators of various ratings. The equipment contains all the components shown within the dotted lines of Fig. 3. The equipment is completely metal enclosed to provide protection for this vital apparatus, safety for personnel, and prevent unauthorized persons from tampering with the equipment. The enclosed design also meets the requirement of modern power plant design for improved appearance. Adequate ventilation is provided to prevent over-

heating of the apparatus. All of the components are accessible for adjustment, test and maintenance.

The "drawout type" field circuit breaker, mounted in the left end unit (Fig. 1) is electrically operated, but may be manually operated. The circuit breaker section can accommodate a second breaker in the lower compartment for a spare exciter if one is required.

The center unit (Fig. 1) contains the voltage regulating devices. The circuits are shown in Fig. 3 and operate in the following basic manner.

A three-phase signal voltage which is directly proportional to the generator terminal voltage is supplied to the voltage regulator by the potential transformers. This signal voltage is fed into a network which converts it to a single-phase voltage. The latter is then applied to the regulating circuit. The field of the amplidyne is supplied directly from the regulating circuit output, the polarity and magnitude of which depend on the variation in the a-c generator terminal voltage from normal.

When the a-c generator voltage is higher than normal, the regulating circuit supplies current to the amplidyne control field, so that the amplidyne voltage will oppose, or buck, the exciter voltage across the exciter field circuit. This will tend to reduce the exciter field current, lower the exciter voltage and decrease the field current and terminal voltage of the a-c generator toward normal.

Reactive ampere limit equipment is provided to prevent the regulator from automatically reducing the a-c generator excitation to such a low value that there is danger either of loss of synchronism or of excessive heating at the armature end fittings. This equipment limits the leading power factor reactive current to a predetermined value. This latter value is automatically varied as a function of kilowatt load so that with the machine at light load, a larger underexcited reactive current is permitted than at high kilowatt loads. This allows for the same safe operating margins at all times.

The lower panel, in Figs. 1 and 2 (center section), is the voltage regulator panel, and the middle panel contains the reactive ampere limit equipment. On the top panel are mounted control devices, such as the amplidyne motor starter and the transfer contactor. The panel mounted on the side of this section (Fig. 2) contains the various auxiliaries, such as equalizing reactor, stabilizing transformer and motor operated voltage adjusting rheostat.

The amplidyne m-g set and the exciter field rheostat are mounted in the right end section (Fig. 1). The rheostat is motor operated so that it can be adjusted from the switchboard.

Small generators generally do not require as precise and fast regulation as the larger machines, therefore, the regulating equipment is of the simple direct-acting type and it is usually more convenient and practical to mount the regulator at the switchboard. However, "drawout type" field breaker equipments are also available for the smaller generators. These equipments incorporate all the features described for the larger breaker equipments. Mounting and connections are provided for the field discharge resistor and the field ammeter shunt as shown in Fig. 3.

The use of unified excitation equipments will pay dividends in improved continuity of service and safety; simplified and better station layout; less costly installation; and greater ease of operation and maintenance for the station attendants. The power station designer will find this approach an answer to many of his excitation problems.

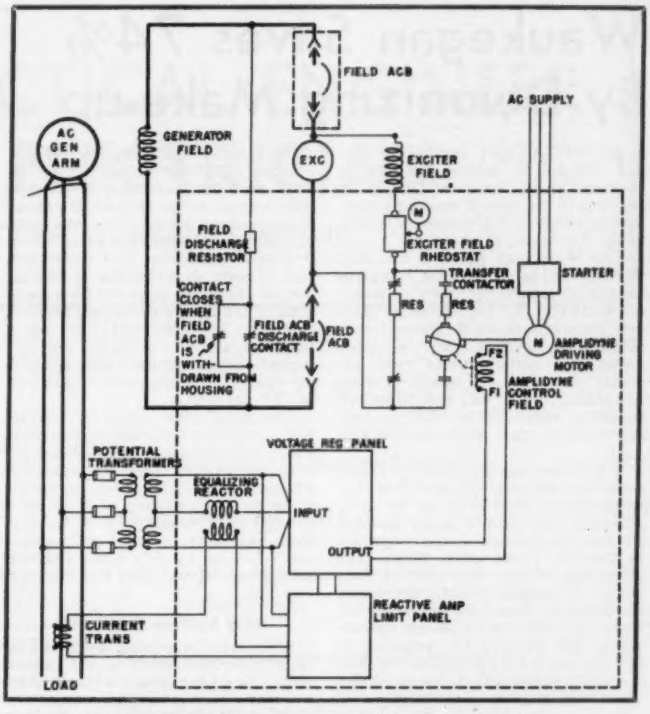


Fig. 3. Schematic diagram of excitation and voltage regulation system. The dash line surrounds all components mounted in the enclosing case shown in Figs. 1 and 2

Fig. 4. Drawout type field circuit breaker withdrawn, in position for inspection

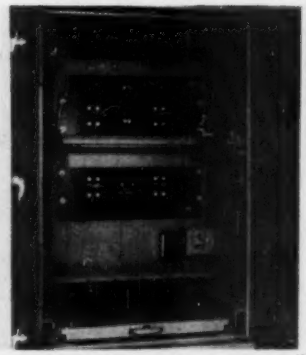


Fig. 5. Drawout type field circuit breaker compartment with breaker removed

Waukegan Saves 74% By Deionizing Make-up

DEIONIZATION instead of distillation is saving the Public Service Co. of Northern Illinois 74 per cent in the cost of treating make-up feedwater for high-pressure boilers at its Waukegan power plant.

The Waukegan plant is the first central station to install a complete deionizing system for treating make-up feedwater for high-pressure boilers. The evaporators it replaced were already in operation on the three boiler and turbine units most recently installed. In addition, the deionizing plant will condition all make-up water for an 1800-psi unit scheduled to start operation late this year.

Two three-stage systems for silica-removing deionization have flow rate capacities of 120,000 lb per hr each, although this rate is rarely utilized because the two sets normally operate in parallel. These units, which take advantage of the high-capacity Amberlite exchangers recently developed by Rohm & Haas Co., will condition make-up water for six boilers operating at 350 psi, for 10 operating at 650 psi, and for the proposed 830,000-lb-per-hr cyclone-fired reheat boiler which will operate at 1800 psi.

Raw Water

Analysis of raw water from Lake Michigan showed about 156 ppm (as $CaCO_3$) in total ionized solids; total hardness of 130 ppm (as $CaCO_3$) and a silica concentration of 5 ppm (as SiO_2). Although the system was installed only after thorough preliminary engineering studies, it was checked, soon after the shakedown run was concluded, to establish complete data on hardness, silica content, total ionized solids, pH values and other factors.

Saving by Deionizing

Treated water was found to average 3 ppm in total ionized solids, giving an electrical resistance of approximately 200,000 ohms per cm, to have zero hardness and to have a silica concentration of about 0.2 ppm. Total cost of deionization was running about $0.12 per 1000 gal of water treated — including the estimated cost of resin amortization as well as that of chemicals required for regeneration. Thus, the estimated over-all cost for 5,000,000 gal — a year's make-up water — is $6,000 for deionization, as contrasted with $23,000 for evaporation, a saving of $17,000 or 73.9 per cent.

The installation, made by Infilco, Inc., includes a duplicate set of cation, anion, and silica-removing elements, with one aerating tower for removing carbon dioxide. The cation exchange units have diameters of 8 ft and straight-shell heights of 6 ft; the weak-base anion exchange units measure 6 ft 6 in. by 6 ft 6 in., and the strong-base anion units 6 ft 6 in. by 7 ft 6 in.

How System Operates

After salts have been converted to their respective acids in the cation units, the strong acids are removed as the water passes through weak-base anion exchange resins, with Amberlite IR-4B carrying most of the burden. Silica and the remaining traces of carbon dioxide are removed in the final unit by the strong-base anion exchange resin, Amberlite IRA-400.

The cation exchange material in this installation uses two charges, each of 125 cu ft. Each weak-base anion unit contains 100 cu ft of resin, and each strong-base anion unit (for silica adsorption) contains 85 cu ft.

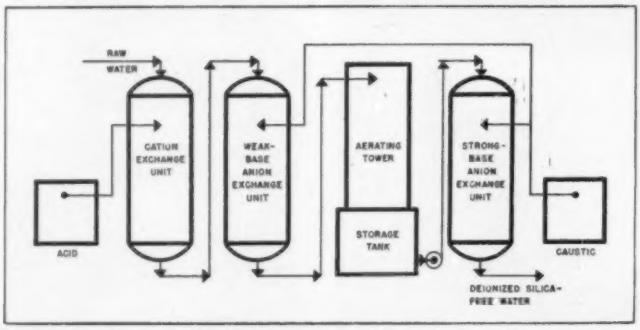
About 3.26 lb of 66 deg Bé H_2SO_4 per 1000 gal of water treated are required for regeneration of a cation exchange unit. Each strong base anion exchange unit requires 0.40 lb of caustic for the same quantity of water treated. This caustic is recovered and utilized for regeneration of the weak base anion exchanger, thus appreciably reducing operating costs.

Between regenerations, each cation exchange unit is able to condition 92,000 gal of water; each weak base unit, 480,000 gal; and each strong base unit, 750,000 gal.

Comparison With Evaporation

Operation of this plant is demonstrating four major advantages of three-stage silica-removing deionization over evaporation: an assured, adequate supply of conditioned water, low first cost of equipment, low operating costs and low maintenance costs. Deionization is producing a water of consistently high quality despite a wide variation in the quantity required — a variance intolerable in the normal operation of evaporators. Initial cost of deionization equipment was estimated at approximately 60 per cent of that of evaporators of equivalent capacity. Also, the ion-exchange units require much less space than evaporators, though some of this advantage might be forfeited where raw water requires pre-treatment before reaching the ion exchange unit.

The cost of deionizing treatment is much lower than that of evaporation, particularly in view of heat losses suffered through evaporator blowdown and degradation of heat in the evaporator to a lower pressure. Maintenance savings are realized because corrosion of piping and equipment is held to a minimum. This results because the carbon dioxide, never totally removed from water after evaporation, is completely removed by deionization.



Schematic flow diagram of deionizing installation for feedwater make-up at Waukegan Station of Public Service Co. of Northern Illinois

LOS ANGELES TO PIPE WATER 10 MILES FROM COLORADO RIVER

PROPOSED route of a pipeline which will be the city's main source of water supply from the Colorado River was submitted for approval recently to the Board of Water and Power Commissioners by Samuel B. Morris, general manager of the Department of Water and Power of the City of Los Angeles, Calif.

Estimated cost of the line is $7,000,000. It will require over 10 miles of 68 in. diameter pipe. When completed, the line will add 171,000,000 gpd to the Department's capacity for taking Colorado River water. That is almost half of the city's current total demand.

The pipeline will start at the San Rafael tunnel of the Metropolitan Water District in Eagle Rock, and terminate at the Department's Hollywood Reservoir. Included in the project is a new regulating reservoir in the hills above Hillmont Ave. in Eagle Rock.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

WE RECEIVE AN OSCAR

SOME two and a half years ago, on an afternoon in April 1949, to be exact, Oscar the Owl sat on the firing roof of a creosote still. The sun was in his eyes, so he didn't see Elmer the stillman drawing a bead on him with a 12-gage shotgun. It was a momentous and critical moment and the terrible tragedy was averted only by the quick action of our friend John Raven, hitting Elmer's arm just in time to substitute the smokestack for Oscar. Oscar was saved! That, indeed, was our first introduction to Oscar—the beginning of a relationship that has extended through these pages to this day. Oscar has become an important influence—his prescient judgment in matters concerning human nature has saved John from many encounters with his volatile boss. ¶ We, the editors, of course, have known Oscar only through his cryptic messages to John Raven—we have never seen him. Naturally, we were curious, and often wished we had a picture of him. Knowing him to be an elusive creature, however, we had little hope of getting one. Imagine our surprise, therefore, a couple of weeks ago to receive, by mail, not a picture, but a porcelain replica of Oscar, and almost at the same time a letter from John Raven. "Coming down to Charleston (S. C.) from my Navy duty in Washington," he wrote, "we followed the Skyline Drive in Virginia, and stopped overnight at a hotel in the Smokies of North Carolina. And there, in the dining room on a cabinet shelf, what did I see but twin replicas in porcelain of Oscar, the Gas Works Owl. As you might expect, both Oscars came to Charleston and one is being sent to you." As might be expected, Oscar now occupies an important place in our offices, sitting on a block of South Carolina pine as you see him in this picture.

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A Section of POWER ENGINEERING Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
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New Air Meter for Combustion Control

Here is a new device for indicating flow of combustion air to boiler furnaces. . . . Designed to give reliable indication in clean air that will be closely proportional to square of air flow throughout range of boiler operation. . . . Meter is over 80 per cent efficient, provides ample head for actuating combustion control pilot, causes very small fan power loss. . . . Complete details given for design and construction of the meter

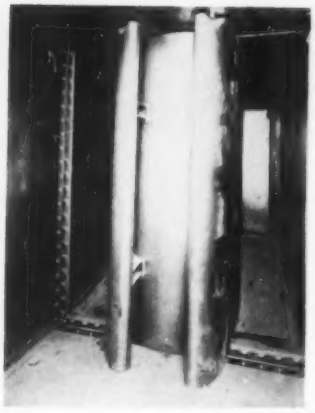


Fig. 1. Air meter installed in combustion air duct of No. 2 Boiler, Russell Station. It had to span expansion joint, hence auxiliary airfoils had to be supported from main section

REASONABLY accurate measurement of the amount of combustion air being fed to a furnace is an important problem in the operation of large high-pressure boilers. The head measurement should be ample for actuating a combustion control pilot and remain proportional to the square of the air flow throughout the entire range of boiler operation.

Methods now used to obtain such air flow measurements include use of boiler draft loss, and orifices or venturis in combustion air ducts. The first two have many disadvantages; the last can be used only where physical arrangement permits. However, a new device, described below, is designed to form a simple efficient air meter that will give consistent control impulses over a wide range of boiler operation.

What the New Meter Is

The new air meter consists of a main airfoil section with two auxiliary air foils just ahead of it, all mounted in the air duct transporting the combustion air to the furnace, as shown in the illustrations. The airfoil produces a restriction, accelerates the air flow around the main airfoil and produces a differential head. This differential is measured by pitot tubes at two points on the airfoil, as shown, and provides the measurement and control impulse.

This air meter is an adaptation designed to approximate a short venturi. It was described in detail by I. G. McChesney of Rochester Gas & Electric Co. in a recent issue of *Combustion*. A model of it was first tested in a wind tunnel, then designs were developed for installation on No. 1 and No. 2 boilers at Russell Station. Following are the principal points of the discussion and data given by McChesney.

Draft-Loss Method Difficulties

A draft loss in the boiler system that is suitable for the measurement of gas flow and that can be used for combustion control is difficult to find, he says. About the only benefit in measuring gas flow by draft loss is that no fan power is consumed. This cannot compensate for the many disadvantages of this type of measurement. Also, draft-loss measurements are not proportional to the square of gas flow because of many interfering variables, such as:

1. Changes in gas temperature with load
2. Changes in percentage of CO_2
3. Fouling of the tube bank that is selected for draft-loss measurement
4. Fouling of draft-tube connections
5. Difference in height of draft connections
6. Changes in the distribution of gas flow in the section where the draft measurement is made, caused by the inherent characteristics for the particular tube section, fouling, or the effect of changes in damper position. Automatic dampers controlling steam temperature usually do not have a definite setting for a given boiler output
7. Time delay which causes improper control impulses when gas-flow measurements are used instead of air-flow measurements.

Past experience with draft-loss impulses actuating combustion control pilots has been unsatisfactory for many or all of the reasons listed. Thus, a new method of combustion air measurement was required — a method which would supply control impulses essentially proportional to the square of air flow throughout the range of operation.

The orifice is not a very good solution to the problem of metering combustion air because it offers little guiding effect, its length being only the thickness of the orifice plate. For this reason it does not maintain a constant flow pattern throughout the wide range of boiler operation. Some type of restriction similar to a venturi tube would be an improvement in this respect. However, relatively long runs in forced-draft ducts are unusual, and it becomes necessary to adapt the venturi to the duct dimensions.

Air Meter a Venturi Form

The air meter is such an adaptation designed to approximate a short venturi. It has a symmetrical streamlined form, and not only accelerates the main body of the air stream but in addition guides smaller high velocity air streams along either side of the main airfoil. Normally the head measured by a venturi tube indicates the acceleration imparted to the main air stream. In the case of the air meter, this indication is approximately doubled due to the high-velocity layer that flows close to the outer surface of the airfoil.

Figure 2 is a diagram of the air meter, and a set of curves showing the variations in pressure along the duct wall and surface of the main air-

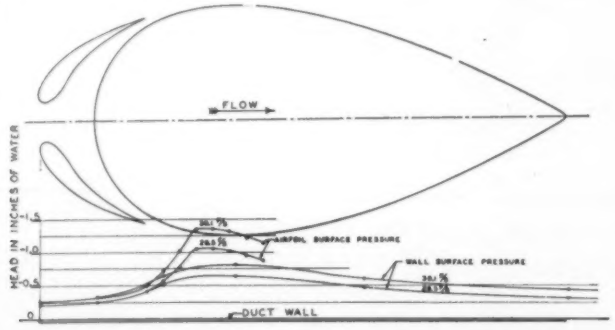


Fig. 2. Diagram of air meter test, showing head characteristics

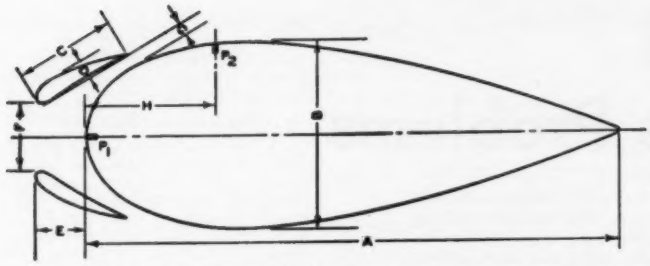


Fig. 3. Dimensions of air meter as given in Table I, in percentages of length. Note pitot tube connection points P_1 and P_2

Table I. Air meter design dimensions in per cent of length, for No. 2 boiler meter, Russell Station

Design Dimension	No. 2 Boiler Meter
A	100
B	35
C	19.38
D	3.24
E	9.68
F	12.92
G	2.69
H	25.0

Table II. Co-ordinates for determining shape of airfoils in air meter; data in per cent

Main Airfoil Section		Auxiliary Airfoil Section	
Chord x%	Camber ± y%	Camber + y%	Camber − y%
0	0	− 1.33	1.33
1.25	5.53	1.67	4.33
2.50	7.64	3.20	5.33
5.00	10.38	5.00	6.33
7.50	12.25	6.53	6.73
10	13.68	7.53	6.87
15	15.62	9.20	6.60
20	16.76	10.20	5.93
25	17.36	10.80	5.20
30	17.52	11.07	4.53
40	16.95	10.80	3.00
50	15.45	10.00	1.93
60	13.32	8.60	1.20
70	10.68	6.73	0.67
80	7.66	4.60	0.33
90	4.23	2.47	0.13
95	2.35	1.27	0.13
100	0.36	0.13	0.13

foil with respect to the impact pressure at the nose of the main airfoil.

An outline sketch of the air meter giving critical dimensions is shown in Fig. 3. These dimensions are given in Table I, and co-ordinates for the airfoil shapes in Table II.

Table III. Comparison of power required for measuring air by air meter and by orifice. Data obtained on No. 2 unit, Russell Station

Kilowatt load	70,000	46,600
Steam Flow	470,000	300,000
Net plant heat rate	9,515	9,633
Coal flow, lb per hr	49,530	33,280
Total airflow, cfm (100 F)	132,970	93,300
Metered air from F.D. fans, cfm (100 F)	112,000	80,000
Useful control head, in. H_2O	2.10	1.07
Head loss with air meter, in. H_2O	0.37	0.19
Head loss with orifice, in. H_2O	0.84	0.43
Fan head with air meter, in. H_2O	11.20	5.72
Fan head with orifice, in. H_2O	11.67	5.96
Fan power with air meter, kw	239.9	158.7
Fan power with orifice, kw	250.0	165.3
Power saving using air meter, kw	10.0	6.6
Efficiency of air meter, per cent	82	
Efficiency of orifice, per cent	60	

Design Details

The gap between the wall of the duct and the sides of the main airfoil controls the velocities in the system. This gap is designed to give an acceleration that will increase the velocity head half the amount of the differential head required on the air meter. For example, if air is flowing at a temperature of 560 F and the maximum velocity in the duct is 55.5 fps, the main airfoil of the air meter constricts the duct, accelerating the air to a velocity of 118 fps. Thus, the velocity head in the duct is increased from 0.35 in. to 1.59 in. of water, an increase of 1.24 in. This acceleration causes an air meter differential of 2.45 in. of water.

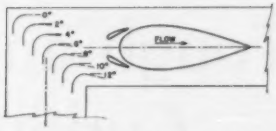


Fig. 4. How air meter is installed in a typical right-angle air duct, with vanes for air distribution. Note how vanes are bent beyond 90 deg, by amounts indicated, for reasons given in text

Vaning Ducts

A typical arrangement of the air meter in a duct is shown in Fig. 4. Note that there is an elbow in the duct just ahead of the air meter. Quite often it is difficult to find a long straight run of duct in which to install the venturi tube. However, by putting vanes in the bend as indicated, a satisfactory air distribution flow pattern can be achieved. The air meter should be located as far as possible from the discharge side of the vanes so that the velocities in the streams leaving the individual vanes may have time to equalize.

Air is not evenly guided around a 90-deg turn but tends to pack against the guiding side of each vane. Higher velocities occur close to the vane and when the air is released by the vane, it does not follow the trailing edge but takes a lesser angle. For this reason it is necessary to turn the trailing edge beyond the 90 deg position. This is shown in Fig. 4.

Power Requirements

The power requirements for friction loss of the air meter and a comparison with requirements for an orifice plate are shown in Table III.

The air meter will accelerate air enough to multiply the velocity head of inflowing air seven times. The author recommends it as an efficient measuring device that will give consistent control impulses over a wide range of boiler operation.

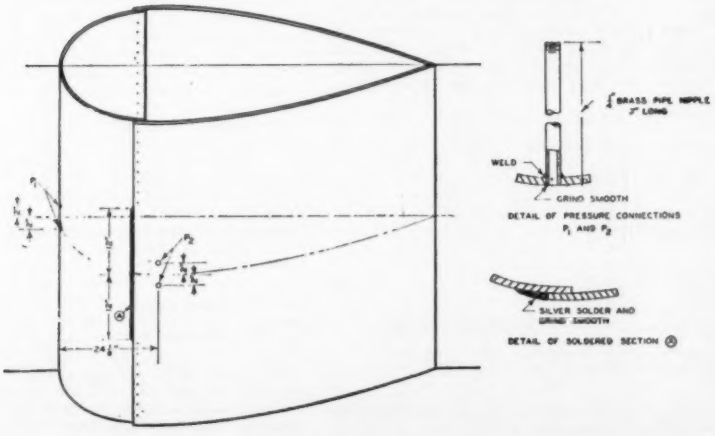


Fig. 5. Details of main airfoil construction of air meter. It can be made of ⅛-in. sheet if care is taken to prevent wrinkles. If stiffeners not used, trailing section should be lapped outside nose section. If stiffeners used, they back up a butt joint between sections. Slight leakage between plates or at top and bottom connection to duct will not affect performance. However, lapped sheets at pressure connection should be smoothed out as shown. Note that pressure connections P_1 and P_2 are in pairs so they can be interchanged if there is plugging or leakage

Tough and Curious Problems

Here are related a number of problems from the notebook of Wilbur G. Hudson when he was field engineer for a large manufacturing company making heavy conveying machinery. They are indicative of the many and often baffling situations the field engineer has to solve in doing his work

IN THE COURSE of running this Practical Engineer section we are frequently asked, "who is the *practical* engineer, what does he do — how does he differ from any other type of engineer?" This is a good question but one not easy to answer.

By virtue of its very nature, all engineering must be practical, otherwise it wouldn't work. Well, then, if all engineering is practical, why differentiate — why indicate a specific category? The term Practical Engineer arises, of course, from the fact that the actual application of engineering knowledge requires not only knowledge of basic principles — things best learned in schools — but also skill in applying these principles, which is obtained largely by experience. There is a considerable difference between knowing how a thing ought to be done, and actually doing it. A person may know a great deal about the chemistry of combustion, about boiler design, construction, and operation, but until he has actually tried to operate a boiler he will find that there are a great many things he still has to learn. It is the accumulation of such skills and detailed knowledge of just how a piece of machinery is made and how it responds to certain stimuli that finally makes a man a practical engineer. A practical engineer is not necessarily lacking in academic training, though many of them have never been to college.

The practical engineer is more than a mechanic. A mechanic usually is a man skilled in one trade but often, he is not familiar with the theoretical aspects of even his own trade. Thus an electrician may know how to install electrical equipment of various kinds but he may know very little about the basic principles of electricity.

A good practical engineer, say the engineer of a small steam power plant, will not only know how to install and operate every piece of equipment in the plant but will also understand the basic principles of thermodynamics, hydraulics and electricity. Such a man would not make the mistake as did some city firemen in Chicago a number of years ago of trying to take suction from Lake Michigan when their fire engines were parked on a bluff some 45 feet above the water level. Even the firemen should have known this.

The term, practical engineer, however, is not necessarily confined to the field of steam engineering. It is equally applicable in the construction field or in plant engineering. Thus a good master mechanic in a large factory or a field engineer for a manufacturing company may be a practical engineer. Their long experience in handling machinery and materials coupled with their basic training in fundamentals make them capable of meeting a great variety of situations and solving all sorts of tricky problems. Often such men are required to rectify mistakes made by others.

The following actual cases from the experience of Wilbur G. Hudson will serve to illustrate what we mean. These are all problems that Mr. Hudson encountered while engaged as a field engineer for a manufacturing company making heavy conveying equipment. They, incidentally, will also indicate why field engineers become prematurely grey.

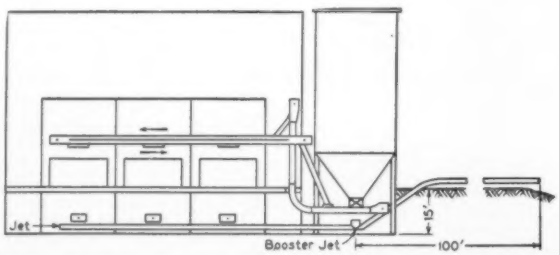


Fig. 1. This hydraulic ash disposal installation failed to function until the hand-hole cover above the booster jet was removed; then the trouble ceased

The Buoyant Sludge Pit

In the installation of a waterside chemical plant in Baltimore part of the material handling installation involved a waterproof concrete sludge pit 100 ft long, 10 ft wide and 12 ft deep with a 12 in. reinforced floor and sides back of the bulkhead. The sludge is handled from pit to barges by grab-bucket. Pouring was completed in the afternoon — a beautiful job.

That night, however, a frantic phone call from the erector told that the pit was lifting with the incoming tide. The possibility that this heavy box would float had not been considered remotely possible. A midnight inspection showed it had lifted two feet and was still going up. What to do? A fire alarm was turned in from the corner box, and a few minutes later, two engines were busy pumping river water into the pit. Soon it was level full. As the tide ebbed it moved downward sweetly to within a fraction of an inch of its original position. It was given no chance to repeat the performance. The customer evidently had political influence because there were no complications with the fire department.

Why the Ash Would Not Pump

The owner of a small steam plant in Bridgeport, Conn. desired coal and ash handling equipment. The coal handling layout was routine. He desired an ashes conveyor arranged to fill a swampy area one hundred feet distant. Dustless operation was essential, and he rather favored a sluicing system since water at one hundred pounds was available. Why not? It meant a low cost job — two hundred feet of 8 in. pipe, two elbows and three intake castings. The only complication was that the boiler house basement was 15 ft lower than ground level. However, empirical data indicated that by a booster jet at the foot of the short incline, the mixture of water and ashes could make the climb and move on to the end of the run.

It did not work out that way. With the end jet and the booster jet on full, the flow stopped at the upturn, backed up, popped out the intake covers, and flooded the basement floor. The prospect for final payment looked dim.

Wading over, the writer opened the handhole cover of the up-turn elbow. Immediately there was an inrush of air due to the injector action of the booster jet, and the water streamed up along the pipe, carrying along the ashes very nicely. Apparently the injected air lightened the mass, increased the velocity, and the steam carried on. The purchaser was very pleased with his ashes disposal sys-

tem. The writer stopped en-route home for two drinks.

Saving a Thousand Dollars

For a new coal washing plant in West Virginia, the salesman secured a nice order for five 36 in. belt conveyors to handle the wet, sticky rejects. A supplement allowed $1000 extra for a device which would clean off the belts better than the rotary spiral rubber cleaners they were using. The salesman explained that these should be the inclined disc wipers which had proved effective on an Ohio installation some years earlier. They were installed but failed to clean off the muck. A long distance phone call to Ohio elicited the information that the disc wipers had been discarded long ago. Several modifications were tried without success, and while thinking up something else, plain scrapers were placed, and the customer stationed a truck under each conveyor to catch the drippings. Each scraper took off some of the dirt, and it was evident that if there were enough of them the belt would be cleaned. The device shown in Fig. 2 was provided for one belt, then for all five. They earned the $1000. Three years later, the operator said they were still in service — "the best he ever had." However, some deposits are so obstinate they can be dislodged only by water jets and multiple diagonal steel scrapers.

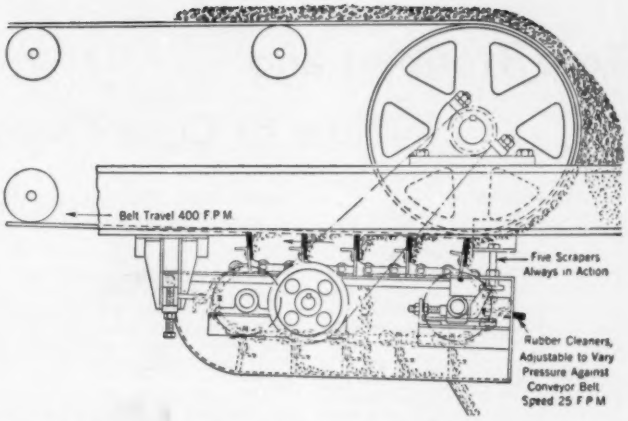

Belt Travel 400 F P M
Five Scrapers Always in Action
Rubber Cleaners, Adjustable to Vary Pressure Against Conveyor Belt
Speed 25 F P M

Fig. 2. Since one belt scraper removed some of the sticky coal dirt adhering to the belt cover, and a second scraper removed more, this multiple scraper was installed. The scrapings are brought back to the main discharge chute by the return run of the scraper

Architects' Specifications

For a municipal sewage disposal plant not far from where this is written, the architects specified two vertical loop-type continuous flow elevators to lift the sewage sludge to the upper floor dryers. This semi-dry sludge is scraped off a belt and chopped up in a shredder. It resembles fragments of black blotting paper — except as to odor, and dried, is a very good fertilizer — with some objection because of its origin.

When the elevators received this sludge, deposits quickly built up on the walls of the duct, jamming the element tightly, and built up peaks on the impellers. There was just a possibility that a bucket elevator with polished stainless steel buckets might do the job, but the architects decided on a re-arrangement which eliminated the elevating feature. Fortunately the architects had written the specification.

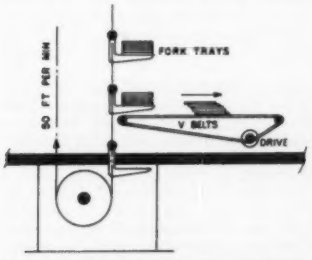


Fig. 3. This V-belt unloader was unsatisfactory because the polished magazine covers were displaced by the sudden acceleration of the piles when transferred to the horizontal run. Gravity outflow was secured by an inclined bank of roller skate rollers. This cured the trouble

A Soporific

These continuous flow elevators do the unexpected sometimes. At a wartime project a small L-path elevator was to receive damp crushed ammonium nitrate from a hammermill for delivery to a dryer. When the material got into the elevator it absolutely refused to pass out, and went round and round. The operator happened to mention a 5 hp compressor in an adjoining room. He was requested to lay a ¾ in. pipe from it up to the discharge end of the elevator with a ⅛ in. nozzle directed against the impellers. The small air jets cleared the load perfectly. On the train going back to Chicago, the author sank into a deep slumber, presumably due to peace of mind, but later learned that ammonium nitrate is a soporific, and so affects one who handles it. Why not take a sample along when one goes on a trouble trip?

A Use For Roller Skates

Four fork-tray lowerers for stacks of magazines, were equipped with multiple V-belt unloaders on the shipping floor. These magazines have a polished pictured cover and the slightest marring of the surface is objectionable. The sudden transition from a 50 ft per min. downward motion to a 30 ft per min. outward movement, caused slippage or a backward shift of the stacks and scraped the covers of one against the next. The tough question was, how could these slippery stacks be made to change direction with no slippage? That one was solved simply by substituting banks of roller-skate wheels, inclined at 8 deg. for the V-belts. When a stack was deposited on these rollers, it stood stationary for an instant, then moved outward by gravity flow, just in time to clear the next descending tray, and with zero slippage.

Uneven Loading

Not only do machines cause complications. Sometimes men do. A West Virginia coal operator asked for a belt conveyor to be located beneath his shaker screen, and an elevator, to take screenings from the coal dropped on the screen by mine cars dumped at the rate of 200 tons per hr. He stated the screenings would amount to not more than 10 per cent. The equipment was designed for 30 tons per hr. to play safe.

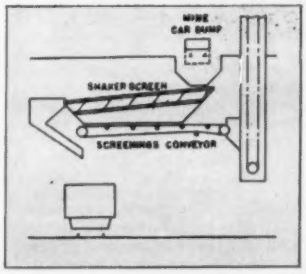


Fig. 4. This screenings conveyor and elevator worked satisfactorily except when the mine car trains came along completely filled with undersize, calling for a capacity of 200 tons per hour instead of 30 tons per hour

What the operator kept under his hat was, that at irregular intervals, the men in the mine cleaned up and sent out trains of fine stuff, nearly all of which was undersize. A conveyor and elevator with a capacity of 200 tons per hr. were installed. He paid for them.

Trap Troubles and How to Cure Them

By **CARL THOMAS**

IN A PREVIOUS ARTICLE the general features of traps and trap hookups were described briefly. Now, the inspection, care and operation of steam traps will be considered.

To insure proper trap operation be sure the steam pressure at the trap inlet is correct. Too high a pressure may damage the element of a thermostatic trap, while a mechanically operated trap may be prevented from opening its valve against the excessive pressure. On the other hand, too low a pressure may not provide sufficient steam for the requirements of the apparatus to which the trap is connected.

Where the trap differential pressure is too low the trap may fail to function properly. To prevent sluggish trap operation the back pressure should not exceed 25 per cent of the inlet pressure.

Before connecting any trap be sure to blow out the pipe lines with full steam pressure, to remove metal chips, thread compound and other foreign material.

When turning on steam to apparatus drained by bucket traps, do so slowly so that the trap will catch the prime and operate properly. Should the trap lose its prime and permit live steam to blow through, close the inlet valve for a few minutes, then open very slowly, to permit the trap to catch its prime. If a discharge valve is provided, close this until sufficient condensate accumulates to prime the trap.

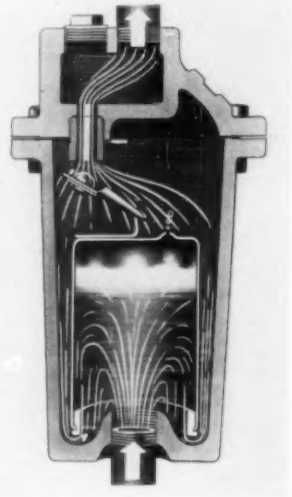
At the periodic inspections, first blow out the strainer or dirt pocket. A plugged valve is convenient for this purpose. Next open the trap test valve, after having removed the valve plug. Where a valve is provided in the trap discharge line, close this before opening the test valve, so that only actual condensate discharge from the trap will flow from the test outlet.

A little experience will help in determining whether a trap is functioning correctly, based on observation of the condensate discharge. Thermostatic, liquid expansion, bucket, impulse and thermodynamic traps operate intermittently. However, the latter two types normally pass relatively small quantities of steam when operating on light loads.

Float traps discharge condensate continuously, throttling the quantity to match the quantity entering the trap.

Flash steam discharging from a trap should not be confused with live steam. The former will appear only when the trap is discharging, but the latter will discharge continuously at high velocity and will have a bluish appearance.

It is good practice to test all principal traps ¾ in. and larger at more frequent intervals, even as often as once a day if conditions warrant.



Section showing the operation of an inverted bucket trap. Photo, Armstrong Machine Works

This will help prevent large-volume leaks and help insure continuity of service.

It is also advisable to test trap returns periodically for chemicals or other impurities leaking into the condensate, if process conditions warrant.

Failure to Discharge

If a trap fails to discharge condensate the trouble may be due to excessive operating pressure, usually caused by failure of a pressure regulating valve. Some types of traps will not open against a pressure higher than that for which they are designed. In checking the trap operating pressure, install the pressure gage on or at the trap. This will show the operating pressure accurately.

When failure to discharge is caused by failure of water to reach the trap the trouble may be due to leakage of a bypass valve below the trap, line or strainer plugged with dirt, line valve broken in shut position, or vacuum in the unit being drained. Where the latter trouble occurs in the coils of a water heater, a ¼ in. check valve may be installed in the line from the coils to the trap, to serve as a vacuum breaker.

Where the trap is draining a rotating cylinder the siphon pipe may be broken or damaged.

If possible, traps should be removed from the line for overhauling or repairs. First the trap should be opened and all sediment removed from the interior with a brush and water. The trap body and parts should then be examined carefully for erosion, wear and other defects. Worn valves and seats should be replaced, in pairs, with new ones. It is sometimes possible to restore worn valves and seats, if desired, by lapping them together with fine valve lapping compound. The valve may be rotated in a hand drill, allowing only the drill weight to hold the valve against the seat. While rotating the valve, also rotate the top of the hand drill slowly in a wide circle. The lapping compound should be completely removed from the valve parts after the job is finished.

Worn or defective operating and other parts should be replaced, and cracks, eroded places, etc. in the trap body or cap should be repaired by welding, if possible, otherwise new parts should be substituted.

Never open a thermostatic trap while hot as the bellows will overexpand and may be damaged. Cool the trap first with cold water or by dipping it in cold water.

When reassembling the trap, carefully clean all gasket seating surfaces and install new gaskets, applying a mixture of oil and graphite to all gasket surfaces. This will help insure their easy subsequent removal. See that all fixed parts are properly tightened and all operating parts correctly assembled before replacing the cover. Then connect the trap to a suitable steam source and observe its operation. If satisfactory, return the trap to stock for future replacement use.

It is necessary to change the valve and seat in certain types of traps when the traps are to be used on a different pressure. The manufacturer should be consulted as to the sizes to be used.

It is well to stock a sufficient quantity of repair and renewal parts, as well as new traps, in order to insure against outages due to delays in shipment of parts orders. This will prove inexpensive production insurance.

Other possible causes of trap discharge failure are worn or defective operating mechanism, trap body plugged with dirt, or, in the case of an

inverted bucket type trap, plugged bucket vent. Failure to install a strainer ahead of the trap may result in the latter two troubles.

If the trap discharges condensate continuously the trouble may be due to insufficient trap capacity. In such a case a larger trap should be installed, unless (in the case of some types of traps) examination shows that the trap orifice is smaller than needed for the trap operating pressure, necessitating merely changing of the orifice.

Continuous discharge in certain types of traps can also be caused by excessive back pressure in the return line, reducing the trap differential pressure below the valve and seat rating.

Where large quantities of water are thrown into the steam lines by foaming or priming of boilers, traps may discharge condensate continuously. The remedy is installation of a separator or correction of feed water conditions. Some inverted bucket traps discharge condensate semi-continuously on very light loads. This might be erroneously interpreted as indicating the need for a larger trap, when, actually, it might be possible to use a smaller size. However, such semi-continuous discharge is satisfactory

When Trap Passes Live Steam

Where a trap passes live steam the trouble may be caused by defective mechanism, worn valve seat or clogging of the valve orifice.

This trouble may also be caused by the trap losing its prime, due to sudden or frequent steam pressure drops or re-evaporation of condensate due to high superheat. By closing the inlet or discharge line valve for a few minutes the trap will usually regain its prime. Loss of prime may be prevented by locating the trap well below the apparatus drained and installing a check valve in the trap inlet line.

Sometimes a trap will operate satisfactorily on test but not when discharging condensate to the return line. This may be due to back pressure in the return line reducing the capacity of the trap. Return line back pressure may be caused by other traps passing live steam, an obstruction in the line or the line being too small, or the vent in the line may be plugged.

A trap may also fail to work properly if the return line has a high vacuum, because this may increase the trap pressure differential beyond the operating range of the trap. In such a case it is necessary to install a higher pressure trap or change the valve and seat assembly.

Where equipment fails to heat promptly despite proper operation of the trap the trouble may be due to insufficient trap capacity, use of a wrong type of trap, lack of sufficient trap air handling capacity, or an undersize steam supply line.

If two or more units are being drained by one trap the cause may be short circuiting. The remedy for such a condition is the installation of a separate trap on each unit.

When a trap on test fails to operate properly or passes live steam, it should be replaced as soon as possible with a new or reconditioned unit. A leaking trap is not only wasteful of steam but may be detrimental to the operation of other traps discharging into the same return line, since the back pressure and temperature in the return line may be increased.

CHECK OUTDOOR INSULATION BEFORE WINTER SETS IN

IN PREPARATION for approaching winter, check to see that all heated lines that are exposed to the weather are properly insulated and finished, advises The Magnesia Insulation Manufacturers Association. Otherwise winds, rain, and snow can cause outdoor lines to lose many times the amount of heat that would be lost by indoor piping. In addition to higher fuel costs, excessive heat losses in the case of hot water and condensate lines may result in freezing.

The following points should be noted in making insulation survey to prepare plant for fall and winter:

1. During the earlier part of the year the hot water system may have been extended to an adjoining building, or new steam or condensate lines may have been run outdoors. Check to make sure that all sections of new piping have been insulated.

2. Outdoor lines should be insulated with ½ in. thicker insulation than would be used for indoor lines operating at the same temperature. This rule should also be followed for lines in open areas such as ramps, loading platforms, sidings, and yards.

3. Insulation on outdoor lines should be finished with asphalt saturated asbestos roofing felt. Insulation on flanges, fittings and valves should be finished with asphaltic plastic weatherproofing.

4. Weather-resistant jackets should be inspected for holes, torn and loose laps, loose or broken wiring, and any other deterioration. Any needed repairs should be made promptly.

"I've found out one thing — for a guy who does nothing but read and make phone calls, the chief knows a lot about generators"

Mineral Wool on Fans Protects Personnel

Induced draft fan on roof of Glenwood Gas Plant insulated with mineral wool blanket

ECONOMY-MINDED plant managers and operating engineers usually measure the effectiveness of thermal insulation in terms of dollar savings in reduced heat loss. Where high-temperature equipment is located in employee working areas, applied insulation also saves valuable man-hours by preventing burns suffered on accidental contact with very hot surfaces.

At the Glenwood Gas Plant of the Long Island Lighting Co., rooftop fan housings enclose the induced-draft fans which draw waste gases, at temperatures from 600 F to 700 F, from boilers through exhaust ducts to the surrounding air. To protect maintenance men who are on the roof to service exposed parts of cracking furnaces, fans and fan motors, the dangerously hot fan housings are covered with mineral wool blanket insulation up to about five feet above roof level. The top portion of the stacks are high enough to be left uninsulated. The blanket insulation, which covers indoor sections of the exhaust ducts, also helps the fans maintain a good draft because the hotter the gases, the better the draw.

The 2-in.-thick mineral wool blankets were secured to the sheet-metal fan housings by welded wires approximately 3-in. long. The blankets, with wire netting on the inside, were impaled on the wires and the ends of the wires were bent over into the metal lath covering the outside of the insulation. After a ¾-in. layer of mineral wool insulating cement was trowelled into the metal lath and allowed to dry, finishing cement was applied and wire netting fitted over the surface and tightly laced. A weatherproof finish was provided by a ¼-in.-thick (when dry) coat of asphalt emulsion.

Ingenious Solution of a Piping Problem

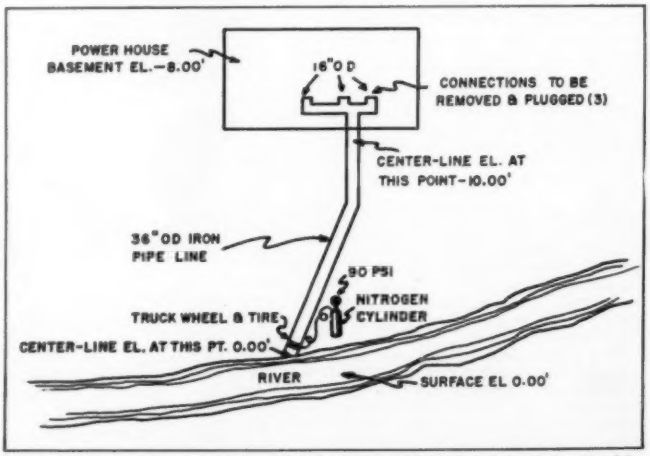
Inflated truck tire is used to block off water in a 36-in. pipe line while piping changes are made in power house

AT THE Ford Motor Co. Hegewisch assembly plant near Chicago, it became necessary to block off a 36-in. cast iron pipe line between the power house and the river. As described by J. A. Kelleher of Kelleher Engineering Co. in the September issue of *Heating Piping and Air Conditioning*, this blocking off was done in a very effective and ingenious manner.

They had dismantled several pumps that had discharged into the pipe line, and were required to plug the openings below the floor to permit refinishing the concrete floor. There was no valve to hold back the river, and the line terminated at the river wall on an angle at a point 18 inches below the surface of the river. The line dropped about 10 ft in the direction of the power house.

The question was, how to plug the 36-in. line while the piping changes were being made. Curiously enough, the solution was simple, once the idea was proposed. They obtained a used truck tire having a diameter of approximately 36 in., as well as a wheel and inner tube to fit. Next, a ½-in. steel plate was welded to the wheel to make it a solid disc. This accomplished, the tire was mounted on the wheel, and with the tire deflated, the whole assembly was placed in the end of the 36-in. line at the point indicated on the accompanying drawing. The wheel was rammed into place with 6 by 9 in. timbers.

The tire was then inflated, using nitrogen, which is handled commercially in cylinders similar to those for oxygen. An oxygen regulator was used in the hose leading to the tube.



Sketch showing the arrangement of the power house, pipe line and the river, and also the location of the truck wheel and tire

With 90 psi pressure in the tire, the wheel was wedged firmly into the pipe, and the line was drained and open for two days, during which time the reconstruction work was carried on.

Not a drop of water came through, but each of the men breathed a sigh of relief when the work was finished. It would have been a serious matter if the plug had become dislodged and the power house flooded.

When Water Level Drops — Don't Do This!

THAT A boiler operator should stop the only pump feeding water into a large boiler operating under a heavy load after he noticed that the water level was dropping seems incredible, yet that is exactly what happened to cause a near serious accident to a boiler operating in the 1000 pound range.

As reported by the Mutual Boiler and Machinery Insurance Co., the boiler, a bent tube, three drum, watertube unit, was rated at 525,000 lb. per hour generating capacity and 977 psi allowed pressure. The furnace was of the dry bottom type, all furnace walls being protected by waterwalls. Pulverized coal was fired from the four corners.

Feed pump equipment consisted of three centrifugal pumps, two driven by steam turbines, the third being motor driven. At the time of the accident, the motor driven pump had been dismantled for repairs. Of the two turbine driven pumps, one could supply the boiler at full load. The capacity of the second would limit operation to about two-thirds capacity.

Feed water level appliances included a prismatic color-sight glass and a level recording chart. Examination of the recorder after the accident revealed that the pen arm was not in proper working condition and it would not return to zero.

Here are the events that led to the failure. The operator, shortly after increasing the load to 400,000 lb. per hr., noticed the water level in the boiler dropping. The larger of the two turbine driven pumps was operating alone at 1200 psi discharge pressure. An attempt was made to start the smaller pump, but it failed to function. With lack of good judgment, the operator stopped the large pump thinking it responsible for lack of flow from the smaller pump. Before the larger pump could be brought up to pressure again, several tubes failed. It was only then that the fuel feed was tripped.

Inspection revealed that the water level had dropped over 30 feet out of the steam drums before the furnace was cooled to safe temperatures. It was only by extremely good fortune that the drums were not burned and the damage confined to a comparatively few tubes.

Here we find involved the results that can be expected when an operator is not fully trained or is not level headed in time of emergency.

How and Why Resonance Instruments Operate

MOST OF US WHO work in or frequent power plants are familiar with the vibrating type frequency meters or speed indicators that are mounted on steam turbines and control panels, and most engineers, no doubt, are familiar with the principle upon which they operate. It is the principle of *resonance* — that quality of an elastic body which causes it to vibrate vigorously when subjected to small rhythmic impulses at a rate equal or nearly equal to its natural frequency. The Frahm tachometers, frequency meters and frequency sensitive relays made in this country by James G. Biddle Co. of Philadelphia are all designed around this principle.

These instruments are almost absurdly simple in principle but great care is required in their construction.

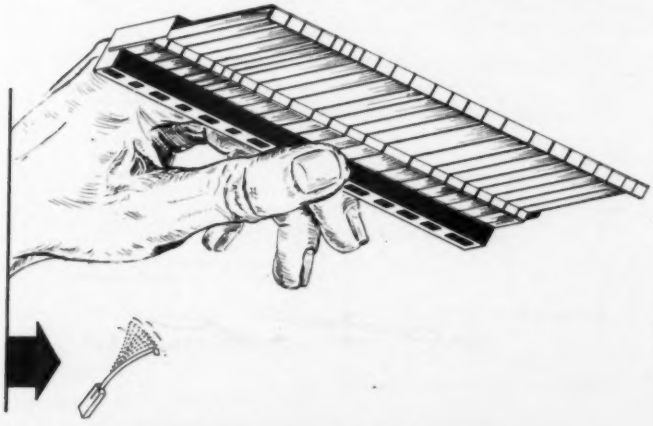


Fig. 1. Tuned steel reeds mounted in a comb arrangement

The tuned steel reeds, which are the resonant elements, are the only working parts of these devices and they vibrate only when activated by resonant vibrations or, in the case of a frequency meter, by an electromagnetic vibrator. The reeds have to be made and tuned with great accuracy.

Frequency Relations

A reed which is to be used to indicate 60 cycles per second obviously requires the same tuning at sixty vibrations per second as does a reed which will be used to indicate 3600 revolutions or vibrations per minute.

Frahm reeds are inherently stable in calibration and when operated under normal conditions there is negligible drift from tuned frequency. This is almost more important than original high accuracy.

Each reed is an individual speed or frequency indicator and if one reed should be out of calibration it will have no appreciable effect on the others. This is quite different from a pointer type instrument, which, if off calibration at one point, is likely to be "off" through its entire range.

Interval Between Reeds

In order to obtain clear indications of small changes of speed and yet have only a few reeds vibrating at one time, the ratio of the interval in rpm or cps at that point on the scale is usually between 0.8 per cent and 2 per cent — e.g., an instrument having a range of 4250 to 5750 rpm for normal 5000 rpm has a 50 rpm interval, which is 1 per cent at 5000. In the case of a frequency meter the intervals at 75 to 120 cps are 1 cps.

Reading a Frahm Resonant Reed Tachometer

With but little practice, readings can be quickly and easily made to one-quarter of the interval between reeds — e.g.:

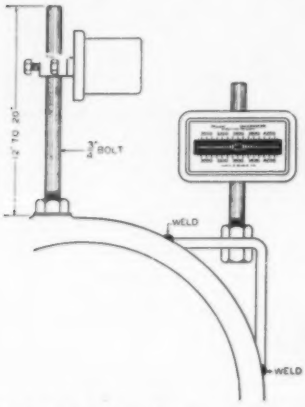


Fig. 2. Methods of providing resonant mountings for tachometers

Reading 3600 rpm
(interval between reeds 50 rpm)

When the amplitude of one reed is at its maximum and the amplitude of those on either side are smaller and equal, the speed is that of the reed vibrating at maximum amplitude.

Reading 3625 rpm

When two successive reeds vibrate with equal amplitudes, the speed is halfway between the tuned frequencies of these reeds.

Reading 3612 rpm

When one reed vibrates at relatively large amplitude and the amplitudes of adjacent reeds are unequal, the speed is determined by interpolation, ¼ of the interval between reeds or about 12; the speed is therefore 3612 rpm.

Amplifying Minute Vibrations

Occasionally, a turbine, for example, may be so well balanced that in the application of a permanent mounting Frahm tachometer it is difficult to obtain a reading. This problem is met with what is termed a *resonant mounting*, being a weight adjustably mounted on an arm (iron rod or bolt) attached to the machine. The tachometer becomes the weight, and with a suitable bracket, the instrument is adjusted to a point on the rod where the reeds vibrate at the best amplitude for reading.

These tachometers are unique because they operate without direct contact with moving parts under test. They give clear indications of the speeds of rotating equipment simply by touching the tachometer to the case of the machine or by mounting it permanently on the case.

Frahm frequency meters operate on the same principle except for the fact that they are electromagnetically actuated.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—

HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your questions from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it And effective! Just ask engineers who have tried it!

Answer No. 481

HOW DO YOU ACIDIZE A WELL?

WHEN THIS question was received from K. R. H. some digging had to be done to get an answer. Three good answers were received and some very interesting information was uncovered. Fig. 1 shows the results of water well acidizing, and Table I is the results of a study of scale deposits found in 15 water wells, representing different producing conditions and areas. Fig. 2 illustrates schematically the four causes of decreased water production. With this information, here are the answers: —

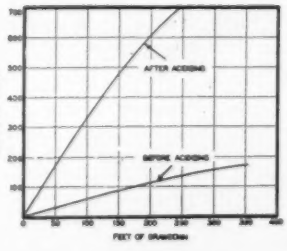


Fig. 1. Results of water well acidizing

Answer 1—Fitzpatrick Says:

BEFORE starting to use acid to increase water yield of a well, several factors should be carefully checked and considered. Loss of efficiency in a drilled well can be attributed to these general conditions (excluding mechanical and pump defects):

1) General reduction of water level through low water supply in the ground

2) Scale formation on pipes which would require acidization

3) Clogging of the well screen. A screen opposite a water-bearing formation is generally originally installed to prevent foreign materials coming into the well proper.

It would be well for reader K. R. H. to check some other neighboring wells to see if part of his immediate problem is from low water levels. At the present time, wells in the Central portion of the U. S. are below their normal rating, due mainly to lack of sufficient ground supply. The water yield of a well depends on the ability of the water-bearing formation; the net draw-down when pumping; the radius of circle of influence (how close one well is to another) and the well diameter.

In checking the neighboring wells, it must be remembered that the water yield of two identically constructed wells with all other factors being equal, is not directly proportional to the diameter of the wells. Doubling the well diameters, will not double the ultimate yield. With a radius of circle of influence of 1000 ft, the following table shows approximate yields from wells of different

diameter — again, assuming identical characteristics:

Well Diameter Inches	Relative Yield
4	1.00
6	1.04
8	1.08
12	1.15
24	1.27

From this tabulation it can be seen that in checking other wells, actual comparison of a 4 in. well against a 12 in. diameter well casing, will show a yield of but 15 per cent additional for the larger diameter well. This is general on both wells being located within 1000 ft of each other and is entirely proportional as distances increase.

Also in this initial investigation of well yields in the immediate area, the ability of rock and soil to transmit water and yield it to a well is highly important. Known as "permeability", it is related to the number of openings in the rock/soil strata and the interconnection of these openings. The "porosity" of the rock or soil is a measure of the amount of void or space present such as the spaced individual sand grains in sandstone.

This porosity is usually expressed as percentage. In 100 cubic-feet of sandstone of 38 per cent porosity, there will be 62 cubic feet of sand particles, solid in state; and 38 cubic feet of open space. However, water extraction by means of a well suction will not exactly equal the total amount of water in the rock strata because a thin film of water will always form on each rock particle, even after the rock has been "dewatered" by pumping.

A check should be made on the "draw-down" of the well. This is a general simple water level measurement and many wells are equipped with a static water-level indicator. This measuring device is not expensive and can be purchased from a well-supply house and will always give a constant indication of the actual amount of water in a well.

When pumping, the water-level is

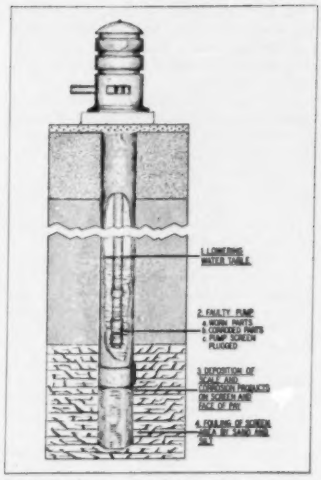

1. LOWERING WATER TABLE
2. FAULTY PUMP
4. WORN PARTS
5. CORRODED PARTS
6. PUMP SCREEN PLUGGED
3. DEPOSITION OF SCALE AND CORROSION PRODUCTS ON SCREEN AND FACE OF PAY
4. FOULING OF SCREEN AND/OR BY SAND AND SILT

Fig. 2. The four causes of decreased water production from a well

lowered an amount called the drawdown, which is the amount the water level is lowered during the pumping state. It is actually impossible to obtain water at a constant rate of "no" draw-down. Water-bearing formations of rock and soil consist of networks of numerous small passages leading to a well. In some instances neighboring wells of high capacity will introduce interference during pumping periods and increase the "draw-down" of a well resulting in reduced output.

Complete information on various well characteristics including K. R. H.'s own well can be secured from a logbook of general well layout which was made when the initial well was drilled. This can be seen at the State Geological Survey offices which are located at Urbana, for the State of Illinois. In practically every case, this Survey has a complete record of the entire well showing the location with respect to ground water supplies and other wells drawing on this supply; total depth; casing construction and diameter; screen; hole-size record; depth, thickness and character of each type of rock or soil penetrated and all crevices, openings, boulders or other unusual features; depths at which water was encountered; amount and depth at which changes occurred in the water-level during drilling; depth of the water level upon completion of drilling; amount of water the well will furnish and dates of starting and completion of drilling.

The Division of Ground Water, U. S. Geological Survey, Washington 25, D. C., can also be of assistance concerning wells in any locale in the U. S. as they interchange well construction operation and installation on a reciprocal basis with each individual state water agency.

In the event the foregoing factors still tend to show that the well requires acidizing due to scale, it can be accomplished efficiently if analysis is made, and procedure understood.

Ground water in a well almost always picks up dissolved hardness as it seeps through ground strata containing lime and magnesium compounds. It is usually free from suspended matter and generally clear. The ground water hardness which tends to scale formation on pipes usually consists of calcium carbonates and bicarbonates.

Well acidizing consists of using a suitable acid to react with the scale materials and dissolve them from the metal well casing. The usual procedure is to use commercial grade hydrochloric acid (muriatic acid). The reaction of the acid against scale is greater with hydrochloric acid than sulphuric, in that the former reacts with greater success against average scale forming materials.

In the chemical reaction, hydrochloric acid forms a water soluble-compound when it reacts with the calcium compound scales. Being cheaper and easily inhibited, hydrochloric acid gains its main economy for its reaction against scale is almost ten times that of sulphuric acid.

Both acids have practically the same reaction on silica scale, which is usually found in small parts in a general well-pipe scale. However, this silica scale is usually porous and the hydrochloric acid with its ten-fold reaction is more efficient.

Wells, however, producing water from sandstone do not generally respond well to acid treatment unless there is considerable limestone percentage in their formation.

For calculation purposes, a 15 per cent basic hydrochloric acid solution in 1000 gallons of water would contain 1343.2 lb of hydrogen chloride, at a specific gravity of 1.075.

This 1000 gallons of acid will dissolve approximately 2042.1 lb of calcium in scale, as calcium chloride. At the same time about 321 lb of water and 812 lb of CO_2 gas will be liberated. The end solution will have a specific gravity of 1.181.

Table I giving a study of scale deposits found in 15 water wells representing different producing conditions and areas

Deposits in Water Well*	
100%—Iron Oxide—FeOOH	5 wells
70%—Iron Oxide—FeOOH 20%—Iron Oxide—Fe_2O_4 10%—Calcium Carbonate—$CaCO_3$	3 wells
15%—Iron Oxide—FeOOH 15%—Calcium Carbonate—$CaCO_3$ 10%—Calcium, Magnesium Carbonate—$CaMgCO_3$ 60%—Silica—SiO_2	1 wel
20%—Calcium Carbonate—$CaCO_3$ 80%—Calcium, Magnesium Carbonate—$CaMgCO_3$	2 wells
35%—Calcium Carbonate—$CaCO_3$ 15%—Calcium, Magnesium Carbonate—$CaMgCO_3$ 50%—Silica—SiO_2	1 wel
70%—Calcium Carbonate—$CaCO_3$ 30%—Silica—SiO_2	1 well
30%—Calcium, Magnesium Carbonate—$CaMgCO_3$ 70%—Silica—SiO_2	2 wells

* From *Water Wells Journal*, Vol. 1, No. 1, 1947.

In the acidizing process, the casing should be vented so the CO_2 goes to atmosphere. The operation of the acid raises the temperature of the acid mixture about 20 F. Periodic concentration tests are necessary to ascertain when chemical reaction has ceased and indicate that all scale has been removed.

A standard pH test can also be taken during different stages of the treatment and also when the acidizing is completed. Water should be pumped and flushed to waste until the pH rises to 7.0.

Acid is usually introduced through a length of tubing into the well interior or through the well pump. Due care should be given to the pump during the latter procedure.

Another method utilized by many well-acidizing companies is to perform the work in steps or stages. The casing is divided into stages and the hole at that point plugged with a sealing compound material. This special compound can be secured from any large industrial heavy chemical house or a well-drilling supply company.

The acid solvent is pumped or poured into this lower and producing section of the well. In about seven to ten hours, this sealing compound will return to a fluid state again to actually uncover this plugged off section.

During the interval, it is possible to work the top stages, working the lower first, then up the pipe. Mechanical circulation can be made of the acid solvent if desired, although the acid reaction time is about identical whether or not a pump is used.

By the use of inhibitors, acid chemical cleaning of wells has become popular, since the acid can be controlled to reduce over-all metal attack to less than one per cent. Inhibitors are sold under various trade names for this specific purpose from large industrial chemical supply companies.

The average results of water-well acidizing in the central section of the U. S. are shown in Table II.

Usually before acid cleaning commences with the sealing of the casing shaft, water production can be materially increased by the addition of acid for the removal of deposits and plugging agents from the well screen.

Also, a bulk acid treatment can increase the water bearing formation strata. Hydrochloric acid is often effective in this instance by dissolving the limestone and dolomites and increasing the size of the openings in the rock at and near the well water entry in the ground.

In one instance, hydrochloric acid was used to loosen and dissolve some old drilling tools that were stuck in acid soluble rocks of limestone at the foot of the well.

Another method of increasing water output is by explosives. Shooting the sandstones increases the yield of a well materially. The quantity and method of employing acid or explosives will depend on a number of factors such as size, depth and construction of the well and the geological conditions present.

Usually a State Geological Survey office will be able to give much information, assistance and professional "know-how" on acidizing or explosive "shooting" a well for additional water yield.

Various special chemically compounded treatments have been offered and used for the rehabilitation of water wells. Some of these produce successful results while others, due to improper compounding and procedure operations during the cleaning, result finally in small improvement.

Many commercial well-cleaning companies are available for well acidizing. One large organization, Dowell, Inc., of Tulsa, Oklahoma, has field service departments in every large area of the country.

— L. W. FITZPATRICK
Jefferson City, Mo.

Answer 2—Fisher Says:

TAKING UP K. R. H.'s questions in order — the process known as acidizing a well consists in filling the lower portion of it, particularly if it is one of the perforated casing wells with a surrounding layer of gravel, with dilute acid, usually muriatic.

This is done to dissolve the incrustations which form in the gravel and on the casing or screen which result from the precipitation of solids from the water when it flows into the well and meets the air. Also, this precipitation probably resulting from the evolution of carbonic acid gas. Such incrustations stop up the openings and prevent the entrance of water.

The usual procedure is to remove the pump and dump enough acid down the well to give about one part of commercial muriatic acid to 19 parts of water in the well. The action is very similar to the chemical cleaning of boilers and the acid should preferably contain an inhibitor to reduce the eating away of the casing. It will act more quickly and effectively if it is heated to 120 to 140 F, though I have seldom seen this done.

The acid should be allowed to stand long enough to partly dissolve and loosen up the incrustation. Then the well should be pumped to free it of acid. While it is being pumped, the water should be agitated with a disc nearly fitting the inside of the casing and mounted on a rod which can be worked up and down in the casing to force the water in and out through the openings in the screen. This should be done until as much as possible of the loose stuff is worked out of the gravel and screen and pumped out.

Any engineer can get the equipment and materials and could probably form an idea of how to proceed by studying the action of suitably diluted acid on some of the incrusting material brought up when the pump is pulled. However, as in any sort of procedure one has the choice of spending time and money learning how or paying some one to teach him.

My own opinion is that for well cleaning, unless one has a number of wells and is thinking of more or less making a business of it, it is cheaper to hire a specialist who knows the tricks of the trade. All the firms who install wells of the gravel screen type have servicemen who can select the best method of cleaning a well and have the equipment to work with. The outfit would be rather expensive to procure for work on one or two wells.

Acid cleaning is merely a means to an end and is used where it is applicable, that is, where the incrusting material can be dissolved or loosened by the acid.

Chlorine has also been used and in some cases has shown a material increase in the capacity of the well treated. It is believed in these cases, which did not respond well to acid treatment, that the incrusting material was of an organic nature.

Dry ice has also been recommended but chiefly to provide a violent agitation in the well because of the large amount of gas formed when it vaporizes.

Apparently the acid cleaning of wells is becoming more frequent, also more effective because of the experience accumulated in this sort of work. This practice does not seem to be limited to any one locality but is used all over the country where conditions are suitable.

We also hear of acid treatment of oil wells but that is a subject outside my experience.

New Haven, Conn. H. D. FISHER

Answer 3—Groom Says:

Acidizing is one of the most effective means of rehabilitating water wells because it is easily applied, comparatively cheap and effective.

Acidizing is the removal of incrustations and corrosion products from the screens and producing formations of a water well by the use of chemical solvents. The solvents may also enlarge the water passages in limestone formations allowing a freer flow of water into the well. A minimum of mechanical work is necessary during

Table II, showing some typical results obtained in increasing well production by acidizing

State	Scale Formation	Gal Acid Used	PRODUCTION GPM Before	After
Kansas	Sandy	3000	154	705
Wisconsin	Sandstone	5000	850	1250
Illinois	Gravel	3000	325	825
Indiana	Sand	1000	150	400
Illinois	Dolomite	2000	133	221

acidizing as the pulling of the pump or the removal of the screen and other mechanical workover methods are not required.

Acidizing is used extensively throughout the United States. A great many water wells are acidized annually for private operators, industrial plants and municipalities. The results in the majority of cases are a return of normal water flow in old wells and an increased flow of water in new wells.

The basic solvent used in acidizing water wells is inhibited hydrochloric acid. A volume of acid from approximately 5 to 7 times the area enclosed by the screen or producing formation is generally used. A small portion of this acid is put through the pump in order to clean up the pump column, impeller and pump screen. This is then pumped from the well by means of the well pump. The bulk of the acid is then added to the well in the area of water production by means of hose or special tubing. In many cases it can be dumped down the well bore. After the acid is pumped into the well it is usually displaced into the formation by water loading. In many instances the acid is surged by starting and stopping the pump.

The acid is usually left in the well from one-half to six hours depending upon the type of deposit to be removed. The spent acid is then pumped away by means of the well pump. The well is always pumped until chemical tests show that all of the acid has been removed.

Acid must be used cautiously. There is always a hazard of putting acid in a well where the fluid can migrate to a nearby well. During the acidizing of a well all nearby wells must be checked to see if they are pumping acid. Another hazard in the acidizing of limestone water wells is that many times a vigorous reaction occurs and the gas involved forces dilute acid up the annulus and over the well property. A pressure type water seal is beneficial in these instances.

Water well acidizing is comparatively simple. However, the amount of chemicals generally required to do the job makes it necessary to handle large volumes of solvent and additive chemicals. This requires transporting, mixing and pumping equipment. Also, experience in acidizing water wells is of great value in determining the technique to use on the particular well.

Tulsa, Okla. C. H. GROOM
Dowell Incorporated

Answer No. 485

IT'S AN OLDIE, SAYS LIVINGSTON

I HAVE NOT TRIED to answer this question, as I can not give a positive yes or no and I do not want to give any wrong advice. However, here are a few observations.

My first experience around steam engines was as an oiler in the old Bryant street steam plant in San Francisco in 1907. The engines were 3-cylinder, triple-expansion, marine engines, rated at 1200-ihp each, but most of the time pulling 1500 to 1800 ihp. There were four identical engines, with a piston valve on the high pressure and balanced double-ported slide valve on the IP and LP-cylinders. The steam pressure was 170 psi gage at the boilers and as the steam line from the most distant boiler to the throttle was over 100 feet, there was considerable moisture in the steam. This plant first went on the line in 1893 or 14 years previous to my employment there.

The engines were equipped with the old hydrostatic lubricators. I was instructed to set the feed at one drop per 100 revolutions. There was also a hand pump on each engine. Occasionally, but at irregular intervals, one of the engines would start a form of vibration in the hp cylinder which I soon learned to recognize, although I never heard one grunt. When this occurred, the engineer would fill the cup on the hand pump with cylinder oil, (about one-half of a water glass), and inject it into the engine. The pump connection was just where the steam entered the hp valve chamber. After a few revolutions the engine would quiet down. For reasons of his own the engineer always did this himself, and never allowed the oilers to do it.

While I was at Bryant St., the hydrostatic lubricators were removed and replaced by Manzel mechanical lubricators. By trial over a period of time, it was found that with these pumps, the proper rate of feed was one drop to 30–40 revolutions. It was the duty of the oilers, on coming on watch, to check the Manzel pumps and adjust the rate of feed.

The piston rods and valve stems were swabbed every 20 minutes. Whenever the slide valves were lifted out for examination, the balancer rings were given a coat of cylinder oil with a brush.

From the above, while the amount of cylinder oil fed was held to a minimum, a certain amount of it was necessary. The cylinder walls were brightly polished.

Oilers in this plant, who had served in the Navy, told me that the main engines in the Naval ships did not use oil in the cylinders but that the heads were removed while the ships were in port and the cylinder walls given a coating of vaseline and graphite.

About this same time I read an article in a technical magazine, but I am unable to recall which one, about an experience the Navy had on this subject. As near as I can remember it, the story was as follows: The Navy had purchased a number of small fore-and-aft compound engines to operate d-c generators. The specifications set a certain maximum steam rate, and provided that no cylinder lubrication be used.

After a time oil began showing up in the condensate, and was traced to the exhaust of the generator engines. These engines were high speed and totally enclosed. Oil from the crossheads and guides splashed onto the piston rods and valve stems, and was carried into the cylinders. To eliminate this, the cylinders were raised, a spacer with a splash plate installed between the engine frame and cylinders and longer piston rods and valve stems installed. As the parts of the piston rods and valve stems that were exposed to the oil spray below the splash plate did not enter the cylinders, the oil trouble was eliminated. However, with oil kept entirely out of the cylinders, the steam rate of the engines exceeded the guarantee. I do not recall what was done, but I remember that the Navy tried several methods of lubricating the cylinders and finally selected the one most satisfactory, as it was agreed that cylinder lubrication was necessary on these small high speed engines.

In 1914 I was, for a short time, in a plant that had an Ideal engine. The chief saw to it that this engine had regular cylinder lubrication, as he said he had found by experience that there would be trouble otherwise. This engine was horizontal. It was a favorite type of engine in its day for generators or belt drives.

HOWARD T. LIVINGSTON
Los Angeles, Calif.

Answer No. 488

WHY USE STEAM TO OPERATE TURBINES?

MY FIRST REACTION to this question is to ask whether it is to be taken seriously, or whether it is a gag asked just to see what will happen.

However, I will assume that S. J. W., in spite of his title, has found a situation that is new to him, and is honestly in search of information.

As to high-pressure compressed air, this is something that does not occur in nature, and can only be obtained by means of an air-compressor. The air-compressor, in turn, requires power in some form to operate it, applied by means of a steam engine or turbine, an internal combustion engine, an electric motor, or a water wheel or turbine. Such being the case, where a steam turbine is the first choice as a prime mover, the solution of the power problem is to apply the steam directly to the turbine and leave the compressed-air plant entirely out of consideration.

As to high pressure water, it can be obtained by two methods; a pump, or in nature. The same objections to using a pump exist as in the case of the air-compressor.

Where high pressure water exists in nature, as in a mountain stream, power can be obtained by running the water through a water wheel or turbine, in which case a steam turbine would not be installed in the first place.

HOWARD T. LIVINGSTON
Los Angeles, Calif.

Basic Power Plant FIGURING

By **WILLIAM H. ENGELMAN**

Mechanical Engineer, Cleveland, Ohio

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How to Check Fuel Oil Volumes, Heating Value; Meaning of Degrees API, Degrees Baumé, Specific Gravity

FUEL OIL is delivered on a volumetric basis. The quantities might be in gallons, barrels, tank-cars, etc., but this has very little meaning, because the heat content or calorific value represents the real value of a fuel oil. In buying fuel oil the most important item is the Btu content, and this item is usually given per pound, per gallon, or per cubic foot.

Coefficient of Expansion

The cubical coefficient of expansion for different grades of fuel oil varies from 0.00035 per deg F at 60 deg for oils up to 15.0 deg API to 0.00045 per deg F at 60 for oils higher than 15.0 deg API. The average coefficient for ordinary Diesel fuel oil is about 0.0004. Due to this expansion it was necessary to establish a basic temperature for the measuring of oil by volume in checking up on deliveries and a correction factor applied to convert the volume at the measured temperature to the volume at the basic temperature of 60 deg F.

Example:

What is the corrected volume of 1000 gal of Diesel fuel oil at 60/60 F if the temperature at delivery was 100 F?

Solution:

Corrected volume is [1.0 − (temp. diff. x 0.0004)]

[1.0 − (40 x 0.0004)] x 1000 = 984 gal. Ans. the difference is 16 gal or 1.6 per cent.

Specific Gravity

The specific gravity of a fuel oil is defined as the ratio of the weight of a given volume of the oil at 60 F to the weight of an equal volume of distilled water at the same temperature, and is written thus: Sp gr 60/60 F. The specific gravity has a decided bearing upon the Btu content and is always given with the analysis.

In the oil industry the Baumé Hydrometer, an entirely arbitrary standard scale, is used for determining the specific gravity. It is a weighted tube marked off into divisions and inserted into the oil. The depth to which it sinks will then give a direct reading of the specific gravity. The gravity of water is taken as 10 on this scale. Liquids lighter than water are given in degrees above 10 while those heavier than water are given in degrees below 10.

The Baumé scale is numbered from 10 to 100, at a Baumé reading of 10 the specific gravity is by definition equal to 1, (pure water at 60 F has a specific gravity of 1 also). The Baumé scale is set up so that the following formulas relate degrees Baumé to Specific Gravity, (deg. Bé to Sp Gr).

For liquids lighter than water:

$$\text{Degree Baumé} = \frac{140}{\text{Sp Gr}} - 130;$$

$$\text{Specific Gravity} = \frac{140}{130 + \text{deg Bé}}$$

For liquids heavier than water:

$$\text{Degree Baumé} = 145 - \frac{145}{\text{Sp Gr}}$$

$$\text{Specific Gravity} = \frac{145}{145 - \text{deg Bé}}$$

Example:

The Baumé reading of an oil is 29 deg. What is the specific gravity and the weight per gal?

$$\text{Sp Gr} = \frac{140}{130 + 29} = \frac{140}{159} = 0.8805 \text{ Ans.}$$

Weight per gal is 0.8805 x 8.333 = 7.337 lb. Ans.

Example:

The specific gravity of an oil is 0.855. Find degree Bé.

0.855 is $\frac{140}{130 + \text{Bé}}$; or $0.855(130 + \text{Bé})$ is 140

and $130 + \text{Bé} = 140/0.855 = 163.75$

finally $163.75 - 130 = 33.75$ deg Bé. Ans.

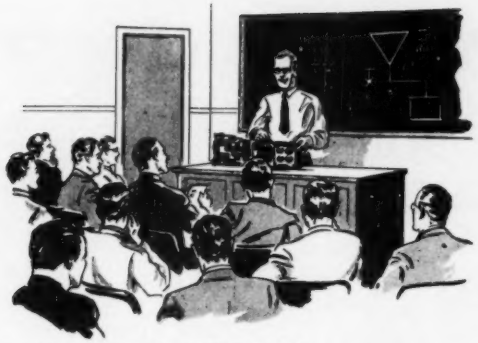
By knowing the specific gravity of an oil it is very easy to convert volume to weight or weight to volume by using a few constants. A cubic foot contains 1728 cu in. and a gallon 231 cu in., this gives 1728/231 or 7.48052 gal per cu ft (use 7.48) and 231/1728 gives 0.13368 cu ft per gal (use 0.1337). The so-called standard oil barrel contains 42 gal or 5.6146 cu ft

CHARACTERISTICS OF AVERAGE OILS. CONVERSION TABLE

Specific Gravity, Degrees Baumé and API, Pounds per Gallon and per Cubic Foot, and Btu per Pound and per Gallon

Specific Gravity	Degrees Baumé	Degrees API	Lbs. per Gallon	Lbs. per Cu. Ft.	Btu per Lb.	Btu per Gal.
0.60	103.33	104.33	5.0025	37.4219	22,395	112,030
.61	99.51	100.47	5.0858	38.0456	22,235	113,083
.62	95.80	96.73	5.1692	38.6693	22,085	114,162
.63	92.22	93.10	5.2526	39.2930	21,940	115,242
.64	88.75	89.59	5.3360	39.9167	21,800	116,325
0.65	85.38	86.19	5.4193	40.5404	21,665	117,410
.66	82.12	82.89	5.5027	41.1641	21,535	118,500
.67	78.95	79.69	5.5861	41.7878	21,408	119,587
.68	75.88	76.59	5.6695	42.4115	21,285	120,675
.69	72.90	73.57	5.7528	43.0352	21,166	121,764
0.70	70.00	70.64	5.8362	43.6589	21,050	122,852
.71	67.18	67.80	5.9196	44.2826	20,937	123,939
.72	64.44	65.03	6.0030	44.9063	20,828	125,030
.73	61.78	62.34	6.0863	45.5300	20,721	126,114
.74	59.19	59.72	6.1697	46.1537	20,618	127,207
0.75	56.67	57.17	6.2531	46.7774	20,517	128,295
.76	54.21	54.68	6.3365	47.4011	20,418	129,379
.77	51.81	52.27	6.4198	48.0248	20,322	130,463
.78	49.49	49.91	6.5032	48.6485	20,230	131,560
.79	47.22	47.61	6.5866	49.2722	20,139	132,648
0.80	45.00	45.38	6.6700	49.8959	20,050	133,734
.81	42.84	43.19	6.7533	50.5196	19,964	134,823
.82	40.73	41.06	6.8367	51.1433	19,879	135,907
.83	38.67	38.98	6.9201	51.7670	19,797	137,000
.84	36.67	36.95	7.0034	52.3907	19,717	138,086
0.85	34.71	34.97	7.0868	53.0144	19,638	139,170
.86	32.79	33.03	7.1702	53.6381	19,563	140,264
.87	30.92	31.14	7.2536	54.2618	19,487	141,350
.88	29.09	29.30	7.3369	54.8855	19,414	142,439
.89	27.30	27.49	7.4203	55.5092	19,342	143,523
0.90	25.56	25.72	7.5037	56.1329	19,272	144,611
.91	23.85	23.99	7.5871	56.7566	19,204	145,703
.92	22.17	22.30	7.6704	57.3803	19,137	146,788
.93	20.54	20.65	7.7538	58.0040	19,072	147,880
.94	18.93	19.03	7.8372	58.6277	19,007	148,962
0.95	17.37	17.45	7.9206	59.2514	18,945	150,056
.96	15.83	15.90	8.0039	59.8751	18,883	151,138
.97	14.33	14.38	8.0873	60.4988	18,823	152,227
.98	12.86	12.89	8.1707	61.1225	18,764	153,315
.99	11.41	11.43	8.2541	61.7462	18,706	154,400
1.00	10.00	10.00	8.3374	62.3700	18,650	155,493

Note: Part of this table has been taken from Chemical Tables, United States Bureau of Standards; Calorific Values were calculated.



and has a weight of approximately 336 lb.

A cubic foot of water at 60 F weighs 62.37 lb.

A gallon of water at 60 F weighs 8.333 lb.

Applying these constants, what is the weight per cubic foot and per gallon of an oil with a specific gravity of 0.8805?

$62.37 \times 0.8805 = 54.92$ lb per cu ft.

$8.333 \times 0.8805 = 7.337$ lb per gal.

Heating Value

The heating value is usually determined by a bomb or Sargent calorimeter. There are several empirical formulas used for calculating the approximate heating value in Btu per pound.

U. S. Bureau of Standards: 22,320 − 3780 x Sp Gr (at 60 F/60 F) = Btu per lb.

Sherman and Kropff: 18,250 + 40 (deg Bé − 10) = Btu per lb.

Example:

What is the approximate heating value in Btu per lb and per gal of a fuel oil whose density is 22 deg Bé? Calculate by both formulas.

Solution:

At 22 Bé the sp gr is 0.921

U.S.B. of Standards: 22,320 − 3780 x 0.921 = 18,839 Btu per lb

18,839 x 8.333 x 0.921 = 144,588 Btu per gal

Sherman & Kropff: 18,250 + 40(22 − 10) = 18,730 Btu per lb

18,730 x 8.333 x 0.921 = 143,750 Btu per gal

This shows a difference of only 0.5 per cent by the approximate method.

American Petroleum Institute Scale, (API)

In 1921 the American Society for Testing Materials in cooperation with the United States Bureau of Mines, the Bureau of Standards, and the American Petroleum Institute adopted the American Petroleum Institute Scale, known as the API scale. The standard temperature for this scale is 60 F and the reading and specific gravity by formulas are:

$$\text{Degrees API} = \frac{141.5}{\text{Sp Gr}} - 131.5$$

$$\text{Sp Gr} = \frac{141.5}{131.5 + \text{degrees API}}$$

Example:

The reading of a hydrometer on the API scale is 28.5. What is the specific gravity?

$$\text{Sp Gr} = \frac{141.5}{131.5 + 28.5} = \frac{141.5}{160.0} = 0.8844$$

Example:

A certain Diesel fuel oil has a specific gravity of 0.9. What is the API reading and what is the weight per gal and per cu ft?

$$\text{Degrees API} = \frac{141.5}{0.90} - 131.5 = 157.2 - 131.5 = 25.7 \text{ deg. Ans.}$$

Weight per gal is 8.333 x 0.9 = 8.000 lb

Weight per cu ft is 62.37 x 0.9 = 56.133 lb

The range for fuel oils is approximately from 10 to 40 deg API.

While the difference between degrees Bé and degrees API is very small it might be required to convert one into the other. The relation may be solved with the following formula:

Degrees API = 1.010714 x deg Bé − 0.10714 (at 60/60F)

10 deg Bé correspond to 10.00 deg API

20 deg Bé correspond to 20.11 deg API

30 deg Bé correspond to 30.21 deg API

40 deg Bé correspond to 40.32 deg API

The value of the specific gravity of a certain oil is constant, whether measured by API or Bé.

Derivation:

How to convert degrees Bé to API

$$\text{Sp Gravity} = \frac{140}{130 + \text{Bé}} = \frac{141.5}{131.5 + \text{API}}$$

$140(\text{API} + 131.5) = 141.5(\text{Bé} + 130)$

$$\text{API} + 131.5 = \frac{141.5}{140}(\text{Bé} + 130)$$

$141.5/140 = 1.010714$

API = 1.010714 Bé + 130 x 1.010714 − 131.5

API = 1.010714 Bé + 131.39282 − 131.5

finally:

API = 1.010714 Bé − 0.10714

These constants can also be used to convert degrees Bé to degrees API

$$\text{Degrees Bé} = \frac{\text{API} + 0.10714}{1.010714}$$

Example:

Convert 29.30 deg API to deg Bé

Solution:

$$\frac{29.30 + 0.10714}{1.010714} = \frac{29.40714}{1.010714} = 29.09 \text{ deg Bé.}$$

It is often necessary to find out which oil is the better buy when quoted on different bases. The following example will explain the method used for comparison.

Example:

Oil No. 1 is $1.85 per bbl of 42 U.S. gal. It contains 18,200 Btu per lb and a density of 27 deg Bé' at 60/60.

Oil No. 2 is $0.0527 per gal. It contains 19,100 Btu per lb and has a density of 31 deg API at 60/60.

It is desired to find the oil which is most economical.

Solution:

Oil No. 1. $\text{Sp Gr} = \frac{140}{130 + \text{deg Bé}}$

Sp Gr x 8.333 = lb per gal

$$\frac{8.333 \times 140}{130 + \text{deg Bé}} = \frac{1167}{130 + 27} = 7.433 \text{ lb per gal}$$

$$\text{Cost per 10,000 Btu is } \frac{1.85 \times 100}{1.82 \times 42 \times 7.433} = 0.3256 \text{ cents}$$

Oil No. 2.

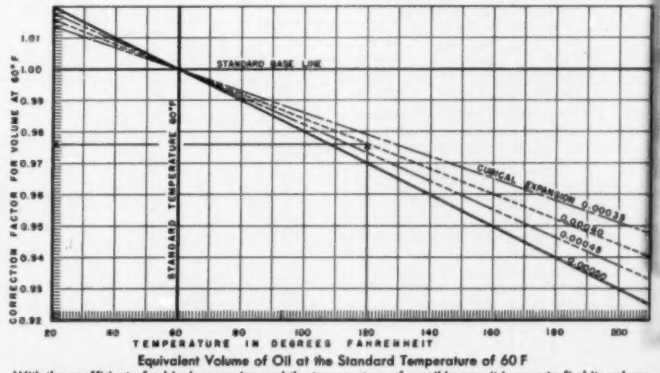
$$\text{Pounds per gal} = \frac{8.333 \times 141.5}{131.5 + \text{API}} = \frac{1179.1}{162.5} = 7.256$$

$$\text{Cost per 10,000 Btu is } \frac{5.27 \times 100}{19.1 \times 7.256} = 0.381 \text{ cents.}$$

All other factors being equal (grade, sulphur content, etc.) oil No. 1 is the most economical.

The cost of oil per gallon is only relative for purpose of sale, but the cost per Btu is the actual cost. For simplicity in calculations Btu should be used in quantities of 10,000, 100,000 or 1,000,000, this will avoid unnecessary decimals as can be seen by the above example.

For further information on fuel oil characteristics, see the articles by Paul F. Schmidt which appeared in POWER ENGINEERING between April 1950 and April 1951. Mr. Schmidt's article describing grades and types of fuel oils appeared on page 86 of the May 1951 issue. These articles now in book Fuel Oil Manual, by Schmidt, published by Industrial Press, 148 Lafayette St., New York 13, price $3.50.



Equivalent Volume of Oil at the Standard Temperature of 60 F

With the coefficient of cubical expansion and the temperature of an oil known, it is easy to find its volume at the standard temperature of 60 F, as shown by the following example:

Example:

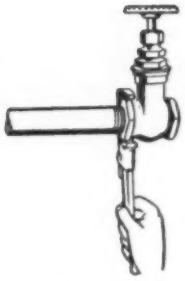
1000 gal of oil with an expansion coefficient of 0.0004 were delivered at a temperature of 120 F. What is the volume at 60 F?

Solution: Locate intersection at 120 F with the line 0.0004, then read at left 0.976; and 0.976 × 1000 = 976 gal at 60 F. Ans.

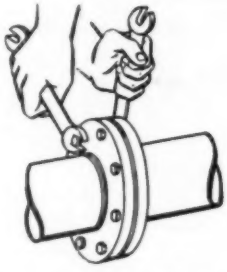
Some Wrench Types And Tips

Always use the proper kind and size wrench when you do that piping job and save yourself time, money and knuckles. Here are some useful tips to help you do it.

Chain Wrench — (Pipe Tongs) — is generally used for larger sizes of pipes (3 in. and above) although they are available for sizes down to ⅛ in.



Monkey Wrench — has smooth, square jaws and is the best one to use for hex end valves and fittings. It gives a good fit on the part to be turned and doesn't have the crushing effect of a pipe wrench. Obviously, because of the shape of the jaws, this wrench cannot be used on pipe or round objects.

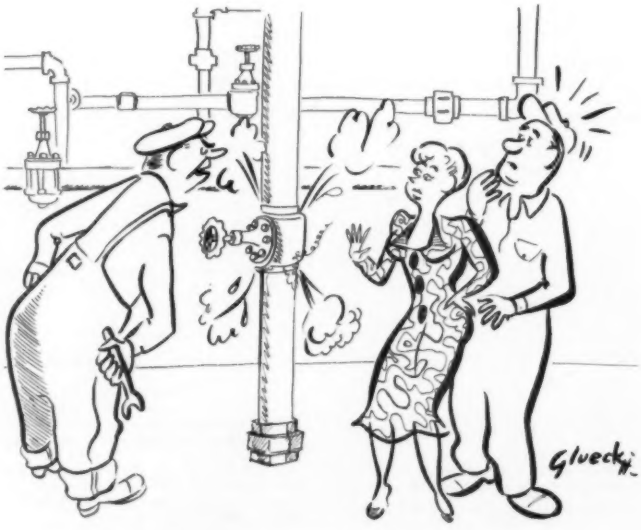


Open End and Socket Wrenches — — are the most suitable and fastest to work with when pulling up flange nuts and bolts. Make sure you use the right size to prevent wearing the nut and bolt heads round and also save bruising your knuckles. Also, see page 92 of the May 1951 issue of POWER ENGINEERING for further information on wrench sizes for nuts.

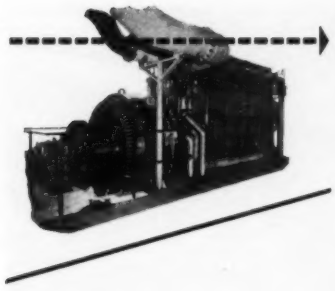
Strap Wrench — is used mainly when working with plated or polished materials to avoid marring the surface. They also come in handy in a tight place where you can't get in with a pipe wrench.

Pictures courtesy of Crane Co., Chicago, Ill.

Pipe Wrench — designed for use on pipe and screwed end fittings only is the crippler in your tool bag when used in the wrong way and place. This wrench is designed so that the harder you pull the tighter it squeezes. This squeezing action can do great damage to a valve such as crippling or crushing its body. If the wrench is too large you can lean on it too hard and run the pipe clear into the valve and damage the seat. Also, to save yourself time and injury, when the teeth on the jaws get worn, throw the wrench away and get a new one.



"I said Stillson *wrench!*—not wench."



Dual-Fuel Diesel at Culpeper Power Plant

Nordberg Duafuel diesel engine powered unit is generating power at the lowest cost in the 16-year history of the Culpeper, Va., power plant. Generating more than 63 per cent of the plant's total, this unit saves more than $9000 a year on the cost of fuel alone as compared with the over-all average performance of the oil-burning diesels in the plant. Also, there have been savings in lubrication and maintenance

THE CULPEPER, VA., municipal power plant went into service in 1934 with three diesel-generator sets. One of the diesels was rated 240 hp and the others, 400 hp each. Power generation for the first year was 1,151,461 kwh. Growth of the load was steady but slow and the original engines sufficed until 1941 when a 750 hp diesel was installed. Power generation for the fiscal year 1941–42 amounted to 2,140,570 kwh. From this point, load development accelerated, reaching 4,315,750 kwh in the year 1948–49. To meet the increased demands, the city installed in August 1948, a six-cylinder Nordberg Duafuel (dual-fuel) diesel engine rated 1220 hp at 327 rpm. This four-cycle, exhaust turbo-charged unit was equipped to burn natural gas with a small quantity of oil for pilot fuel or oil as a full diesel.

Fuel Costs and Resulting Savings

During the first eight months this engine was in service it operated as an oil-burning diesel. In that period, the unit generated 1,554,900 kwh and used 119,138 gal of fuel.

The engine was switched to dual-fuel operation in May 1949. In nine full months of operation on natural gas, the unit generated 2,368,500 kwh with a fuel consumption of 23,625.4 Mcf of natural gas and 13,879 gal of oil.

In spite of the relatively high gas rate of 50 cents per Mcf, the total fuel cost was 5.5 mils per kwh. With fuel costs for the diesels at an average of 8.6 mils per kwh, this represented a net saving of 3.1 mils per kwh. During the year ending March 31, 1950, this unit generated 2,914,600 kwh out of a total of 4,624,700 kwh, or better than 63 per cent. With production at that level, the fuel saving alone amounts to more than $9000 a year.

The natural gas reaches the plant at 25 psi pressure, passes through a meter and regulator and then goes to the engine at 16 psi. The same oil used for operating other engines in the plant is used as pilot oil for the dual-fuel unit. This oil is No. 2 diesel fuel of 34.8 sp gr, rated 139,000 Btu per gallon.

Gas Fuel Gives a Cleaner Engine

Gas fuel results in a cleaner engine and eases lubrication problems. This has been demonstrated with this engine. The naphthenic base lube oil is cleaned continuously in a reclaimer which uses Fuller's earth for filtration. The Fuller's earth in this filter lasts three days when used to clean oil for the oil-burning diesels and seven days when used to clean oil for the dual-fuel engine. In eight months of operation as an oil-burning diesel a gallon of lube oil was used for 5840 hp hr. In ten months on natural gas, (the same engine) a gallon of lube oil was used for 9488 hp hr.

There are two lube oil reclaimers in the plant. One serves the 720 and 1220 hp engines and the other serves the three small engines. The reclaimers serve each of the engines in turn depending, of course, on the condition of the oil and the hours of operation. Lube oil is drawn from the crankcase, purified and returned to the crankcase. The pressure lubricating system of the Nordberg engine includes a shell-and-tube oil cooler, an engine-driven lube pump and a motor-driven auxiliary lube pump. A separate force-feed lubricator supplies the cylinders.

Water and Air

Jacket water for the two large engines is cooled in two evaporative coolers. Water is circulated through the closed systems by motor-driven centrifugal pumps. Automatic thermostatically-controlled dampers bypass enough air around the coolers to maintain jacket temperature at the desired level. Soft city water is used for makeup.

Intake air for the dual-fuel engine is drawn through a combination oil bath air filter and silencer. This provides the engine with additional protection and also helps make it a good neighbor in a community. Exhaust gases vent through a vertical silencer outside the plant. These are shown in Fig. 1.

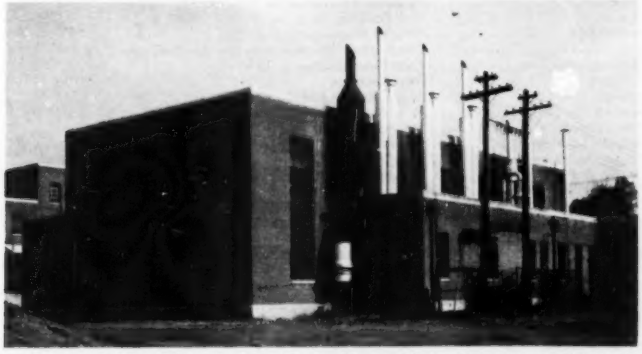


Fig. 1. Rear view of the Culpeper plant. In the foreground are the Maxim exhaust silencer and the intake air filter and silencer for the 1220 hp Nordberg engine

Mounted on the control end of the dual-fuel engine, for convenience in operating, are a multi-point exhaust pyrometer and pressure gages on gas, starting air, cooling water, fuel oil before and after filter, lube oil before and after the filter, and lube oil to the turbo-charger. (Fig. 2)

Operating and Maintenance Procedure

Sound operating procedure is important for successful power generation. There is nothing haphazard in the handling and protection of equipment at Culpeper. For example, a full set of indicator cards are taken every two weeks and corrective action is taken immediately if there is evidence of trouble. The plant has an oil inspection kit of which the principal element is a miniature centrifuge. Lubricating oil is tested every two weeks for asphalt and other gummy materials and dirt, sediment and water, fuel dilution and acidity. The preventive maintenance schedule calls for pulling pistons and complete inspection and servicing every 10,000 engine hours. The power plant staff

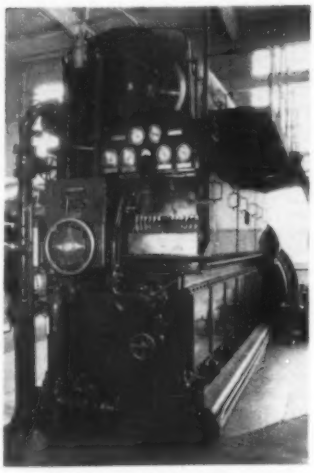


Fig. 2. Operating end of Nordberg engine showing the control wheel, Manzel cylinder lubricators, automatic gas and air intake controls, pressure gages, and Alnor exhaust pyrometer

includes a maintenance engineer whose primary duty is to keep the engines in top condition.

The superintendent of the electrical department and his four operators seek to balance the considerations of relative engine economy and good operating load factor. On a normal weekday, the 1220 hp unit runs from 6:30 a.m. to 11 p.m., half the time at full load and half the time at loads varying from 60 to 75 per cent. From 8:00 a.m. to 5:30 p.m., one or more of the small units (usually the 400 hp) run as necessary to carry the peaks. The 750 hp diesel carries the night

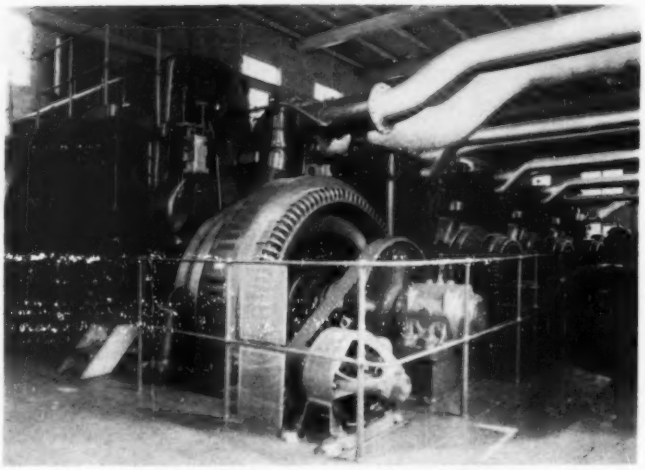


Fig. 3. View of the five prime movers in the Culpeper power plant

load from 11:00 p.m. to 6:30 a.m. Actually the recent growth of the load already has eliminated the power reserve provided by the acquisition of the latest engine a scant two years ago. Bolstered by increased industrial activity, the mid-morning peak runs as high as 1200 kw.

City officials feel that the power plant has been responsible for the increase in load. In the decade from 1940 to 1950, population in the area increased 8 per cent but power production increased 178 per cent. It is felt that dependable, economical power attracted power-consuming industry to the city with attendant employment and prosperity for the citizens. Today, Culpeper has a garment factory, a wire rope factory, two silk mills, a foundry, a chair factory and a saw mill.

The electrical department is managed by Superintendent Farrar with the administrative supervision of City Manager R. W. Huffman. Matters of policy are determined in consultation with Mayor L. Frank Smith and the nine-member City Council. Specially concerned with power plant problems is the Council Power Committee consisting of: R. L. Armentrout, chairman, J. L. Moore and E. J. Eggborn.

List of Allied Equipment for Duafuel Engine

Engine	One four-cycle, six-cylinder, 16-in. bore and 22 in. stroke, supercharged Duafuel diesel engine rated at 1220 hp at 327 rpm. Type FSG-166-SC, Nordberg Mfg. Co.
Generator	Three-phase, 60-cycle, 4000/2300-volt, 1069 kva, 855 kw at 0.8 pf generator driven by 15 kw V-belted exciter. Westinghouse Electric & Mfg. Co.
Governor	Woodward Governor Co.
Fuel oil	Gulf Oil Corp. No. 2 oil
Fuel oil filter	Wm. W. Nugent & Co., Inc.
Gas	Texas & Kentucky Gas Fields (via Gas Distributor Corp.)
Gas regulator	Emco Gas regulators
Gas meter	Hays-Cochrane
Lube oil	Sinclair Refining Co.
Lube oil filter	Wm. W. Nugent & Co., Inc.
Lube reclaimer	The Hilliard Corp.
Cylinder lubricators	Manzel Inc.
Cooling water pumps	Allis-Chalmers Mfg. Co.
Evaporative cooler	Buffalo Forge Co.
Thermostatic control	Mini
Oil cooler	Ross Heater & Mfg. Co., Inc.
Auxiliary lube pump	Tuthill Pump Co.
Intake air filter and silencer	American Cycoil
Exhaust silencer	Maxim Silencer Co.
Switchboard	Westinghouse Electric & Mfg. Co.
Pyrometer	Alnor, Illinois Testing Laboratories Inc.
Pressure gages	Lonergan
Indicator	Bacharach Industrial Instrument Co.
Supercharger	Buchi
Oil inspection kit	The Gerin Corp.

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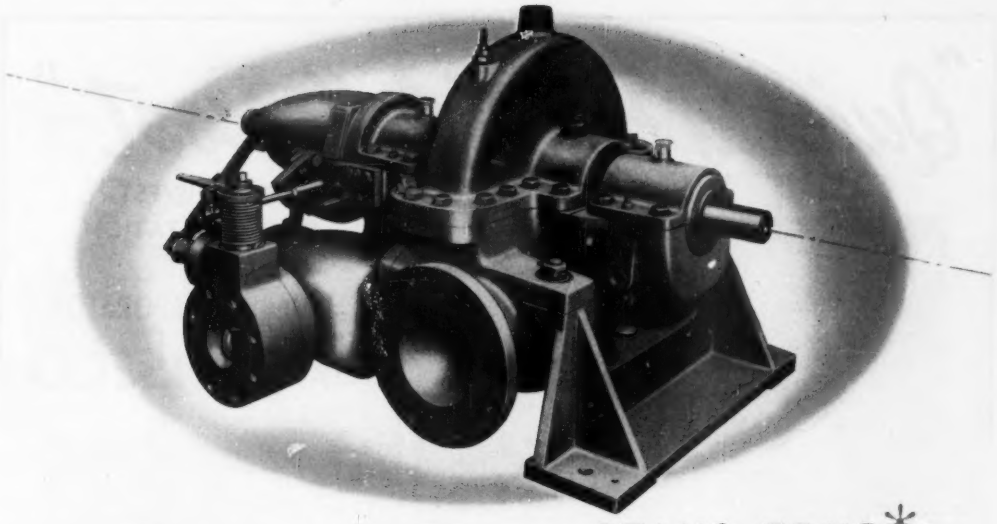
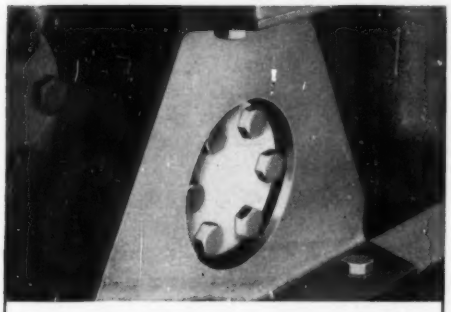


Alignment that *STAYS TRUE** when the heat's on!



Three-Way Centerline Support

* The Type E method of support allows three-way freedom of expansion and contraction without disturbing the alignment of the rotor shaft. The governor end is mounted on a strong but flexible channel beam to permit axial expansion. At the shaft-coupling end, a unique keyed support connects to the turbine near the shaft centerline to permit lateral expansion; and a vertical kingpin transmits thrust from the expanding steam pipes directly to the foundation and not to the turbine. The casing is free to move vertically with expansion or contraction.

Heat expansion can't disturb Type E alignment. The operation of driven equipment is easier, more dependable *—*installation costs are reduced. Westinghouse unique *three-way centerline support* keeps alignment perfect with the driven machine. Strong supports at both the governor and exhaust ends are supplemented by a vertical kingpin that transmits lateral thrust to the foundation. Hot or cold —for constant operation or instant stand-by power, you can depend on the Type E Turbine to "Stay True"!

There are other cost saving advantages, too. Dual protection against overspeed, weatherproof bearing seals, corrosion-resisting gland zones, floating movement of governing and trip linkage, and parts interchangeability between wheel sizes are just a few.

For the full story ask your nearby Westinghouse Steam Specialist for the Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-90520

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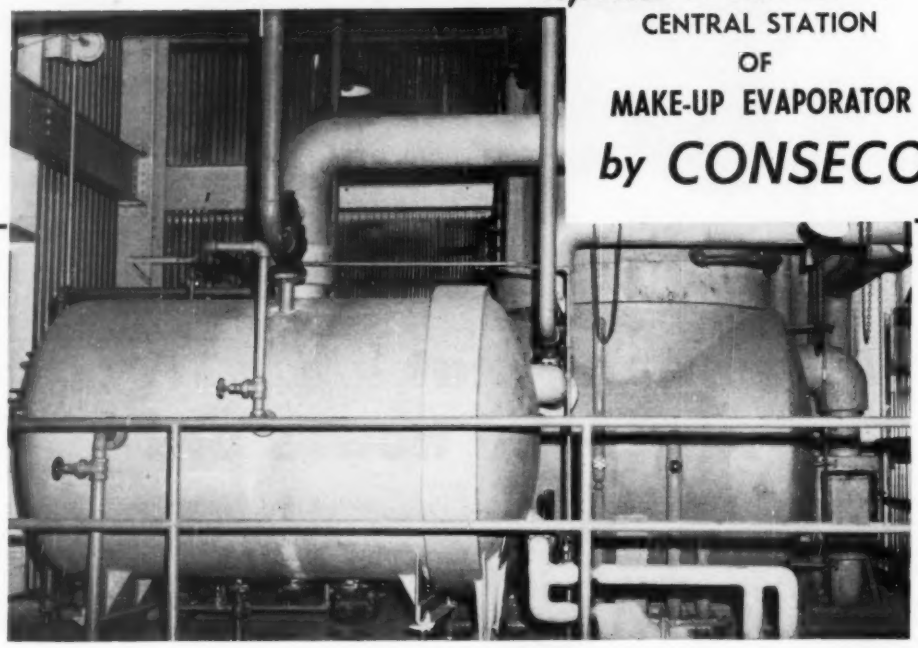
reports SOUTHWEST CENTRAL STATION OF MAKE-UP EVAPORATOR *by* CONSECO



This Conseco Make-Up Evaporator is installed in a large central station in the Southwest. It is a horizontal internal tube nest type unit having a 54 in. diameter shell 154 in. long.

Its output capacity is 4,000 lb. vapor per hour at a purity of better than 4 ppm in the condensed vapor. The unit delivers vapor at 22 psia. using extraction steam at 62 psia. To facilitate bundle removal, the bundle is externally supported on heavy duty trucks and internally on slide rails.

The simplicity and cleanliness of Conseco evaporator design is another typical example of Conseco's many contributions to modern design and construction in power plant equipment. It will pay you to consult Conseco engineers on your requirements.

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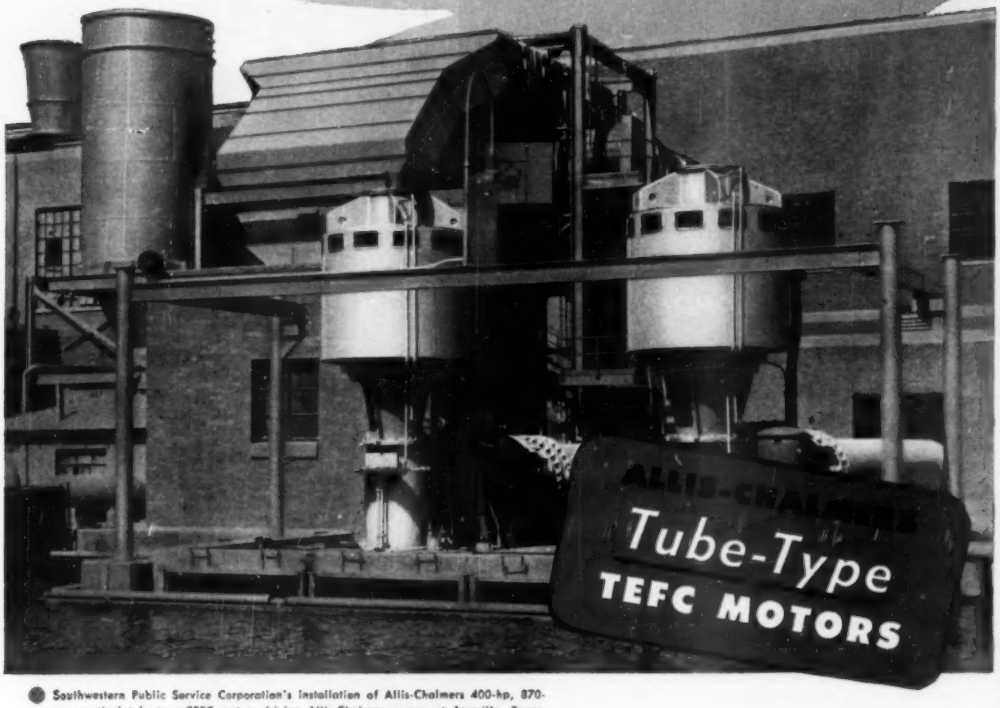


Southwestern Public Service Corporation's installation of Allis-Chalmers 400-hp, 870-rpm vertical *tube-type* TEFC motors driving Allis-Chalmers pumps at Amarillo, Texas.

What does it cost to house a motor? Nothing — if it's an Allis-Chalmers *tube-type* totally-enclosed fan-cooled motor. Then the sky is roof enough. And it need not be blue sky either.

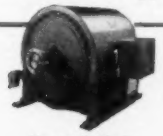
These motors aren't afraid of fog, rain, snow, salt, coal dust, soot, alkalies, or mild acids in the air. They're built to take care of themselves . . . and to save you money. The opportunity for low installation cost is only the beginning. Peak reliability and low maintenance pay worth-while dividends throughout the long life of the motors.

Why? Because their *tube-type* air-to-air heat exchanger design offers you these advantages:

1. *Self-cleaning action* . . . result of generous flow of outside air through smooth, straight cooling tubes.
2. *Complete enclosure* . . . protects stator core and other electrical parts from dirt and corrosion.
3. *Full internal air circulation* . . . provides efficient, even cooling—makes large sizes practical.

These are proved advantages, for purchases have exceeded 170,000 hp in sizes from 250 to 2500 hp. Introduced in 1946, *tube-type* motors are now available down to 40 hp at 600 rpm.

Bulletin 05B7150 describes these motors that are equally at home indoors or out. Call your A-C representative, or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3534



Also available in horizontal designs.

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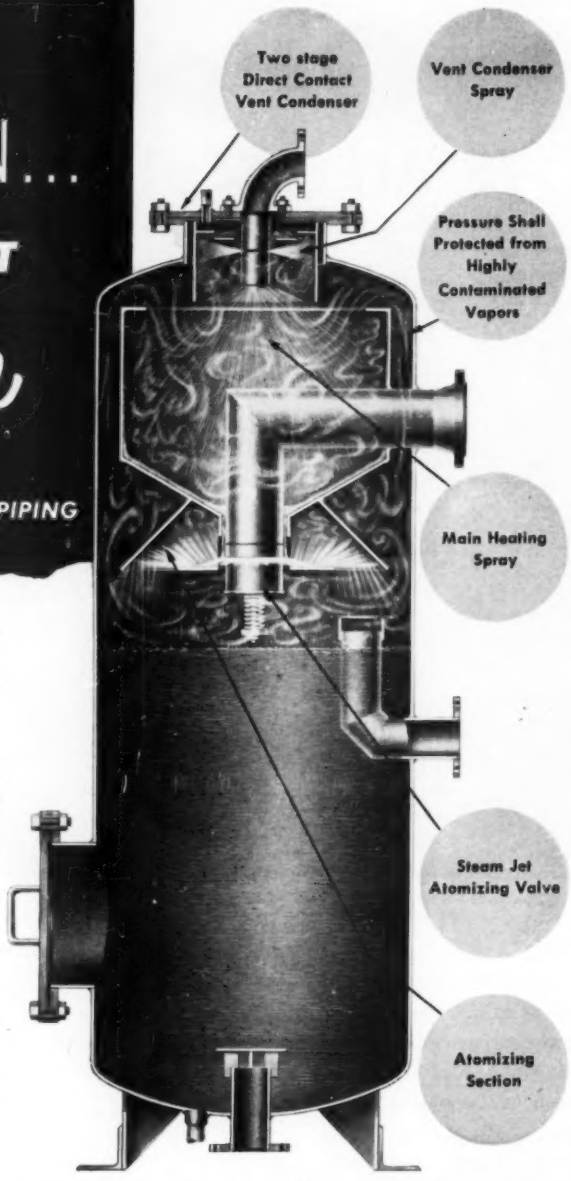
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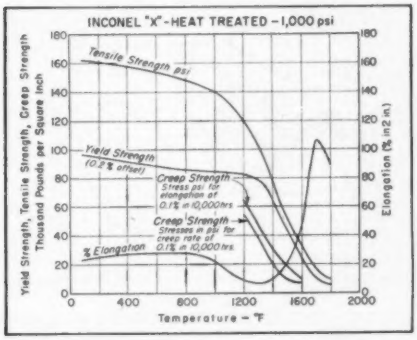
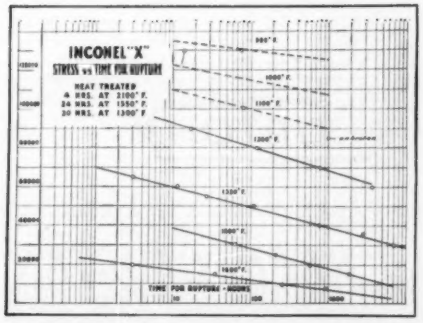
The principal engineering characteristics of Inconel "X" (besides those shown on accompanying charts) are:

- **Oxidation Resistance** – Tests indicate that oxidation resistance of Inconel "X" is of the same order as that of Inconel.
- **Fatigue Strength** – Measurements of fully heat-treated Inconel "X" on rotating beam machines, at 100,000,000 cycles, show fatigue strengths ranging from 55,000 psi at 1200°F to 36,000 psi at 1500°F.


INCONEL "X" - HEAT TREATED - 1,000 psi
Yield Strength, Tensile Strength, Creep Strength Thousand Pounds per Square Inch
Elongation (% in 2 in.)
Tensile Strength psi
Yield Strength (0.2% offset)
Creep Strength Stress psi for elongation of 0.1% in 10,000 hrs.
Creep Strength Stresses in psi for creep rate of 0.1% in 10,000 hrs.
% Elongation
Temperature - °F
0
400
800
1200
1600
2000

Short-time high-temperature properties of fully heat-treated Inconel "X".



High-temperature stress-to-rupture properties of fully heat-treated Inconel "X".

- **Impact Strength** – For fully heat-treated Inconel "X", typical impact strength values are: 33 ft. lbs. at −320°F, 37 ft. lbs. at room temperature, 67 ft. lbs. at 1500°F, and 113 ft. lbs. at 1600°F.
- **Hardness** – By proper heat treatment, the room temperature hardness of Inconel "X" can be developed as desired from BHN 140 to BHN 400.
- **Spring Properties** – By a combination of heat treatment and cold working, Inconel "X" develops unusually high spring properties. For spring applications from sub-zero temperatures up to about 650°F, it is useful where otherwise unusually strong ferrous springs must be used. Up to 1100°F, Inconel "X" springs will give useful performance where few other metals can be relied on.
- **Machining** – Inconel "X" is machinable in all conditions. Because of its strength and toughness, it cannot be machined as easily as softer metals; it can, however, be machined at satisfactory rates.
- **Forging** – No unusual difficulties are encountered in forging Inconel "X", though heavier equipment than that used on ordinary steels is required.
- **Welding** – When planning to weld Inconel "X", first refer data on the job to Inco's Technical Service Section for recommendations. Inconel "X" can be welded by nearly all commonly used methods including: metal arc, inert gas metal arc, atomic hydrogen arc, resistance spot and seam, resistance butt welding.
- **Applications** – Inconel "X" is used for springs supporting television tubes in a face coating dryer. Also for highly stressed bolts and for expansion bellows . . . wherever a combination of high stress and extreme heat must be met.
- **Forms Produced** – Inconel "X" is produced in most commonly used mill forms—billets, rod, flats, rounds, hexagons, sheet, strip, bar, wire, seamless tubes, and welding rods. Like all alloys containing nickel, it is in very limited supply except for defense use.

FURTHER DATA AVAILABLE

A 79-page reference manual "Inconel 'X', Data and Information," *contains all the engineering information compiled to date on this alloy. This publication is available, free, for your information.*

And for technical help on specific problems involving metals at high temperatures, write, outlining your problems, to Inco's Technical Service Section.

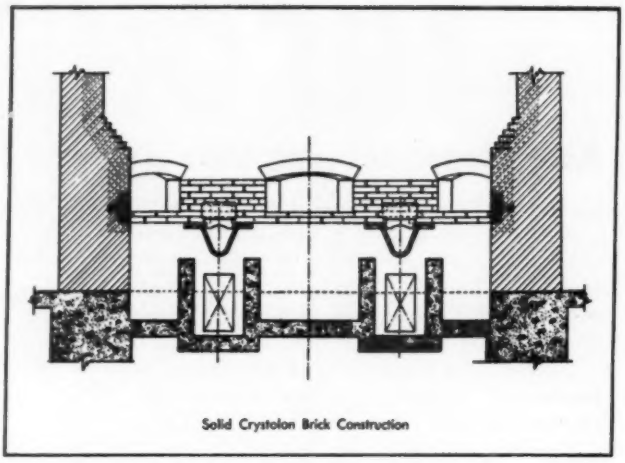
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

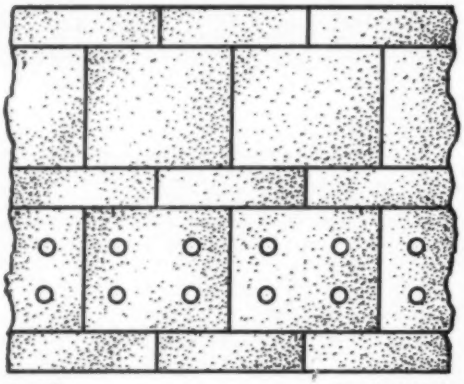
MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"®

THESE BOILER FURNACES

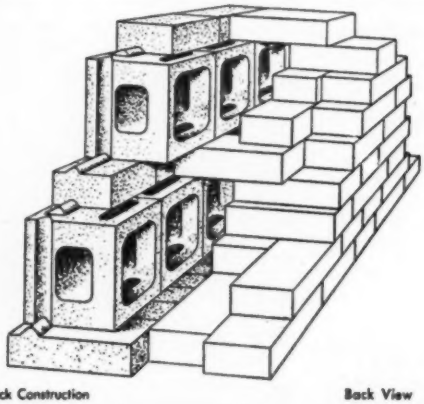
Cost Less to Maintain...



Solid Crystolon Brick Construction



Front View



Back View

Crystolon Air Cooled Block Construction

Because:

NORTON CRYSTOLON* BRICKS OR AIR COOLED BLOCKS at the clinker line, as detailed above, are: (1) so highly refractory that they successfully stand temperatures up to 2900°F; (2) so dense that they effectively resist slag penetration and clinker adhesion; (3) so hard that they are not noticeably affected by abrasion, even that caused by the moving fire bed of stoker-fired furnaces.

WRITE FOR BULLETIN 862

For all the reasons why Norton Crystolon silicon carbide brick is your best buy for long service and low maintenance cost, consult your nearby Norton representative or write direct for Bulletin 862. Norton Company, 615 New Bond St. Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

Special REFRACTORIES

Canadian Representative

A. P. GREEN FIRE BRICK CO., Ltd. TORONTO, ONTARIO

1500 Pounds at 1000°F.

Vogt

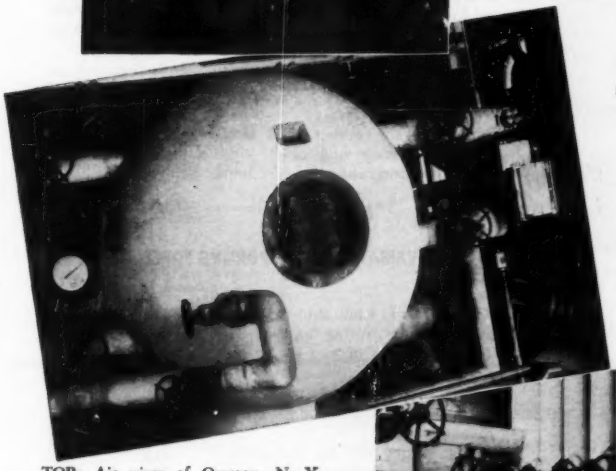
DROP FORGED STEEL

CHROME-MOLY STEAM VALVES

Hold the line at...

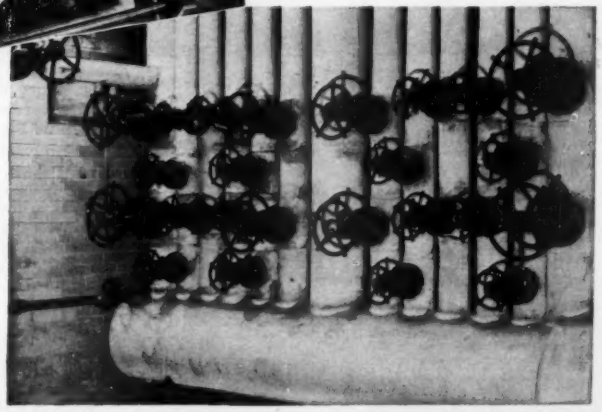
Oswego, N. Y. Station of

*** NIAGARA MOHAWK POWER CO.**



Leading central stations know and trust Vogt drop forged steel chrome-moly valves in their toughest high pressure and high temperature services.
Specify Vogt . . . and be SURE!

**The Huntley Station at Buffalo and Dunkirk Station at Dunkirk, N. Y. use many Vogt valves.*



TOP: Air view of Oswego, N. Y. Station of Niagara Mohawk Power Co.

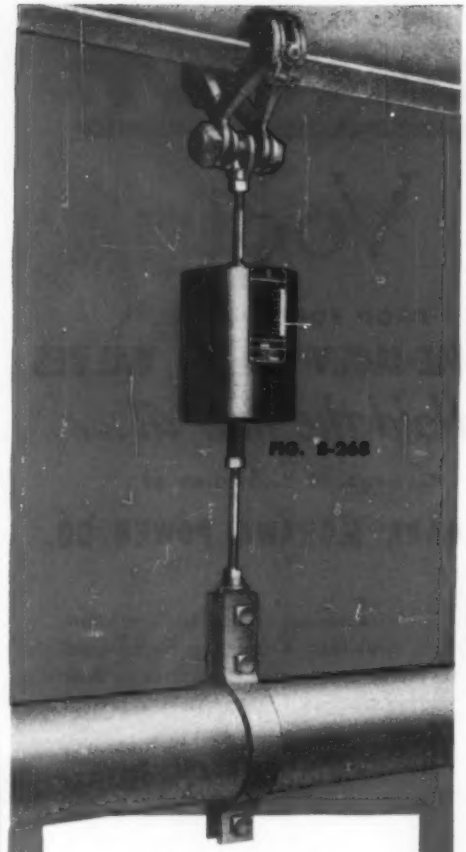
CENTER: Valves on main drum of 875,000 pounds per hour steam generator.

RIGHT: Drains from main steam, attemperator, and superheater lines employ a maze of valves.

NEW CATALOG F-9
Consult its 400 pages for the complete Vogt line of drop forged steel Valves, Fittings and Flanges for steam, water, oil, gas, air and refrigeration services.

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.



Pre-solve Pipe Suspension Problems...

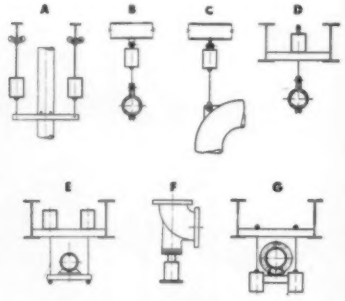
with

Grinnell Pre-engineered Spring Hangers

- Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression* assures operation of spring within its proper working range where variation in supporting force is at a minimum.
- Compact—minimum headroom made possible by precompression*.
- Guides prevent contact of coils with casing wall or hanger rod and assure continuous alignment and concentric loading of spring.
- All-steel welded construction meets pressure piping code.
- 16 sizes available from stock — load range from 74 lbs. to 9000 lbs.
- Easy selection of proper sizes from simple capacity table.
- Installation is simplified by integral load scale and travel indicators.
- Unique swivel coupling provides adjustment and eliminates turnbuckle.

**Precompression is a patented feature.*

TYPICAL APPLICATIONS

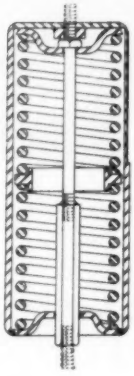


(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

FOR LESS VARIATION IN SUPPORTING FORCE — FIG. 98

Fig. 98 is an adaptation of Grinnell's popular spring hanger, Fig. 268. It consists of two springs arranged in series within a single casing. A centering guide insures the permanent alignment of the spring assembly.

Fig. 98 has half the load deflection rate, and double the total working range of Fig. 268. Its 16 spring sizes accommodate loads from 74 lbs. to 9000 lbs. — but with a total working range *up to 5 inches!* Fig. 98 comes in the same seven types as shown for Fig. 268. Design details for identical types and sizes are the same for Fig. 98 and Fig. 268.



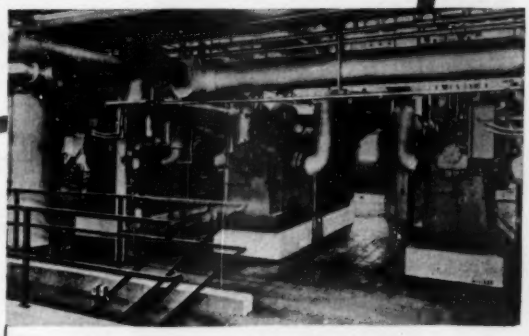
GRINNELL

WHENEVER PIPING IS INVOLVED

GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach • Los Angeles • Milwaukee • Minneapolis • New York Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

What Metals Are Best For Centrifugal Boiler Feed Pumps?

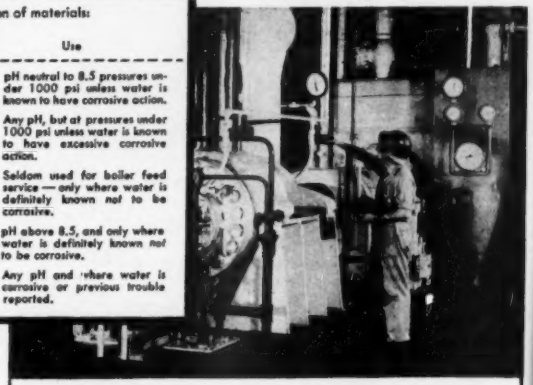
Drawing on their long experience in the field of hydraulics, Worthington engineers produce boiler feed pumps that are metallurgically correct in design, meeting every requirement as to temperature, pressure and corrosion-erosion resistance. As a result, Worthington boiler feed pumps perform better and last longer.



Three Worthington Axially Split Centrifugal Boiler Feed Pumps At The Kansas Power And Light Company Plant, Hutchinson, Kansas.

The following table represents Worthington's recommendation of materials:

Casing	Fittings	Maximum Temperature	Use
1. Cast Iron	Bronze	250 F	pH neutral to 8.5 pressures under 1000 psi unless water is known to have corrosive action.
2. Cast Iron	13% Chromium Stainless Steel	350 F	Any pH, but at pressures under 1000 psi unless water is known to have excessive corrosive action.
3. Carbon Steel	Bronze	250 F	Seldom used for boiler feed service — only where water is definitely known *not* to be corrosive.
4. Carbon Steel	13% Chromium Stainless Steel	400 F	pH above 8.5, and only where water is definitely known *not* to be corrosive.
5. 5% or higher Chromium Steel	13% Chromium Stainless Steel	Any temperature normally encountered	Any pH and where water is corrosive or previous trouble reported.



One of Several Solid Barrel, Radially Split, High Pressure Boiler Feed Pumps at the Trenton Channel Station of the Detroit Edison Co.

This proven selection of materials coupled with the most advanced design, superior workmanship and a thorough knowledge of application show why . . .

THERE'S A *RIGHT* WORTHINGTON PUMP FOR YOU

. . . *right* for the pressure and temperature of your boiler feed service . . . *right* for maximum economy and dependability. For further proof that *there's more worth in Worthington*, contact our nearest District Office, or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

MEMBER

WORTHINGTON

C1.2

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1000 Ft.
For Hotwell, Condensate, Chilled Water Service
Capacities to 1400 GPM
Heads to 650 Feet
For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1600 Feet
For Water Works, Circulation, Drainage, General Service
Capacities to 135,000 GPM
Heads to 400 Feet
For Boiler Feed Service
Capacities to 1600 GPM
Heads to 3500 Feet
For Boiler Feed Service
Capacities to 3000 GPM
Heads to 7000 Feet

How an Engineer

46%

Fred Koenig's notes which were incorporated in his report to the Wagner Brewing Co., Columbus, Ohio, in Oct. 1951.

Cost of new power plant	$128,000
Coal tonnage (old plant)	8,420
Coal tonnage (new plant)	4,700
Fuel costs (old plant)	$ 54,730
Fuel costs (new plant)	$ 32,000
Yearly savings on fuel	$ 22,730
Labor costs (old plant)	$ 41,496
Labor costs (new plant)	$ 19,496
Reduction in present labor costs	$ 22,000
Yearly savings	$ 44,730

Amortization time, new power plant— 2 years, 11 months.

Fred W. Koenig

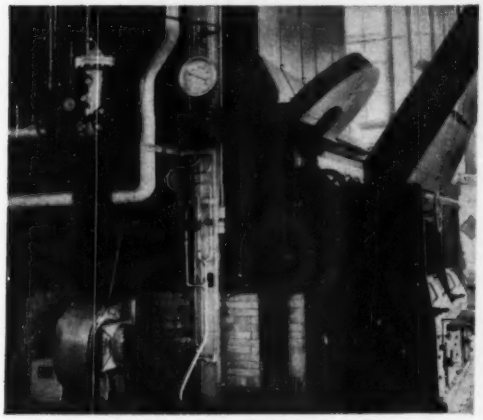
CHIEF ENGINEER
OHIO LICENSE

FOR HIGH EFFICIENCY
FOR LOW COST

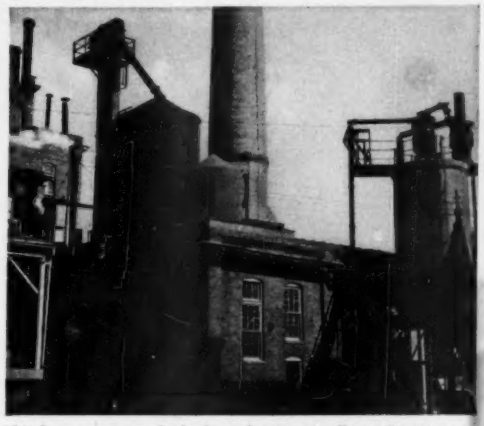
Slashed Operating Costs *with coal!*

IN FIRST YEAR OF OPERATION, NEW POWER PLANT EVEN BETTERS FRED'S ESTIMATE!

Fred Koenig calculated a saving of $40,000. When the figures were in—after the first full year of operation—the saving actually amounted to $44,730!



Here's the coal-fired installation that engineer Koenig recommended, after carefully considering gas and oil as fuels. Specifically designed to get the most energy from today's coals, it saved the Wagner Co. $22,730 on fuel alone in the first year!



This large-capacity silo feeds coal automatically to the Wagner Company's power plant. It cuts handling costs—permits bulk buying of coal at lower rates—assures the Wagner Company of a steady, dependable source of power!

Today, bituminous coal, when used with modern equipment, is the most economical fuel for industrial use. Coal is now more efficient because it's *prepared* . . . washed and cleaned of all impurities. Modern, coal-fired equipment adds from 10% to 40% to the power obtained from the same amount of coal in years gone by.

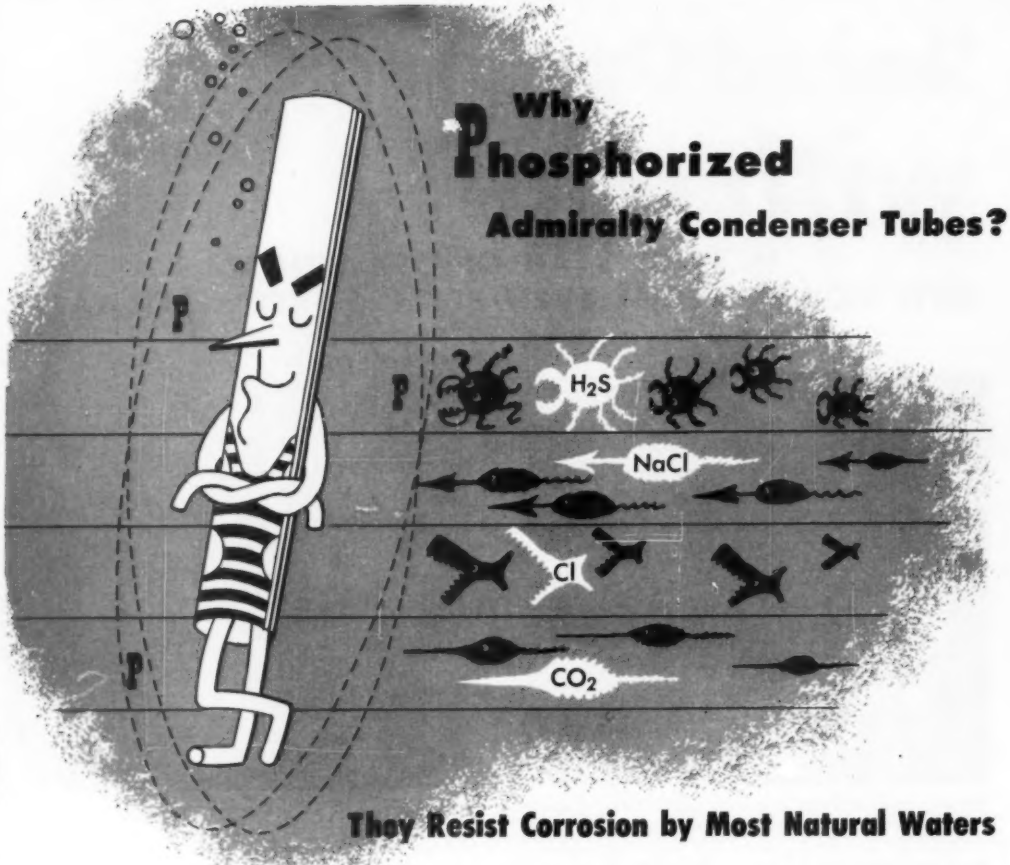
And automatic controls, together with modern coal- and ash- handling apparatus, have dramatically reduced labor costs, done away with inconveniences—*making bituminous coal the best industrial fuel by far!*

America's coal mines are so productive that there will be no shortages to plague the companies that use coal as the source of their power . . . America's ample supply of coal is the best possible assurance that the price of coal will remain more stable than those of other fuels. Coal is always the safest fuel when it comes to both storage and use, factors of more than usual importance in these unsettled times.

BITUMINOUS COAL INSTITUTE

A Department of National Coal Association, Washington, D. C.

YOU CAN COUNT ON COAL!



Why Phosphorized Admiralty Condenser Tubes?

They Resist Corrosion by Most Natural Waters

Whether you use fresh, salt or brackish circulating water, service records testify that Admiralty metal tubes have given very satisfactory performance in stationary power plant condensers.

Such corrodents as carbon dioxide, hydrogen sulfide, chlorine and metal salts, in the concentrations normally found in natural waters, or used in their treatment, are effectively resisted by tubes made of Admiralty.

Adding as little as 0.02% *Phosphorus* to Admiralty gives maximum resistance to dezincification while retaining all the other desirable properties of this alloy.

In order to assure uniform chemical composition and *soundness*, Scovill produces its Phosphorized Admiralty tubes by the continuous billet-casting process which continuously maintains the optimum amount of phosphorus. The tubes are hot-extruded from the continuous-cast billets, then are cold-drawn, annealed, cleaned and finished to produce tubes of uniform temper, gauge, straightness, roundness, diameters, length and freedom from burrs.

A Condenser Tube Booklet is available to qualified users who request it on their business letterhead. Scovill Manufacturing Company, 15 Mill Street, Waterbury 20, Connecticut.

Only Scovill Phosphorized Admiralty Has All These Advantages . . .

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- Excellent performance in fresh, salt or brackish waters
- High resistance to steam and condensate
- Unquestioned heat transfer characteristics
- Superior resistance to general corrosion
- Good resistance to velocities under 7 fps.

SCOVILL

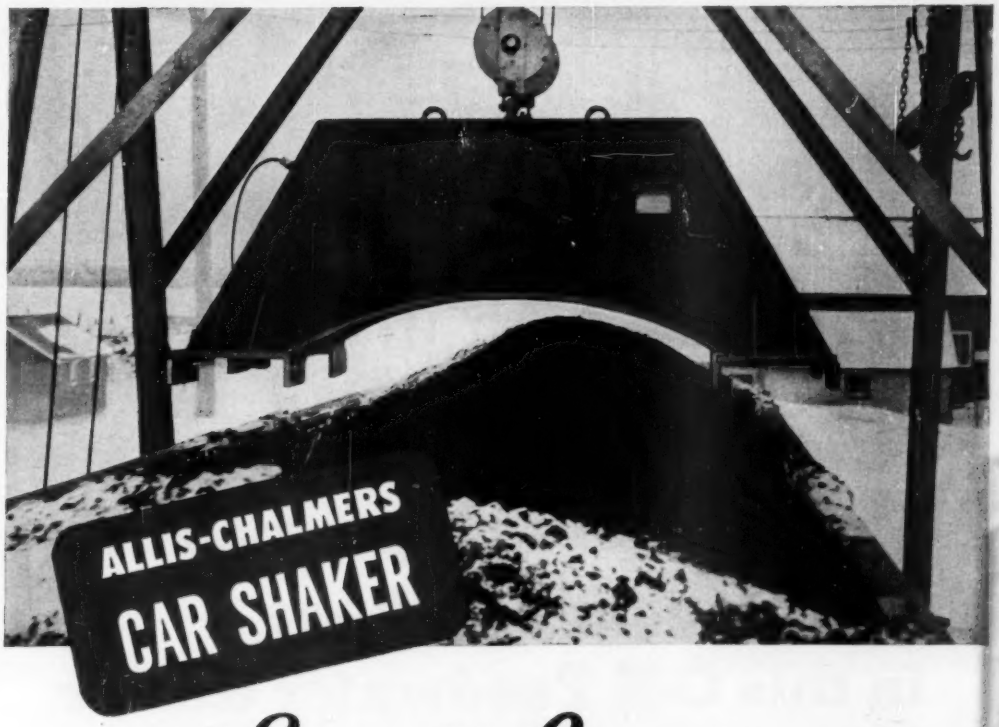
A PRODUCT OF SCOVILL

B-1-5

SCOVILL CONDENSER TUBES

"You can't buy better brass"

FAST UNLOADING



...and Sturdy Construction

BESIDES BIG SAVINGS in man-hours and demurrage costs, operators report savings in maintenance and downtime with Allis-Chalmers car shakers. And no wonder! Allis-Chalmers has designed these units for long, dependable service without trouble. For example:

- Shaker body is one-piece, all-welded structure made of 1 in. thick reinforced steel plate and stress-relieved to eliminate welding strains.
- Motor and drive are totally enclosed within shaker body, protected from weather and accidental injury. Motor is mounted in a special cradle base and protected from vibration damage with multiple shear mountings.
- Extra large bearing — 11⅞ in. outside diameter. Long bearing life! Heavy duty shaft arranged for hydraulic bearing removal.

Get more facts about how Allis-Chalmers car shakers can save money in your operations. Call the A-C representative in your area. Allis-Chalmers, Milwaukee 1, Wisconsin.

Car Shakers Promote Safety to Personnel!

ALLIS-CHALMERS

Allis-Chalmers Mfg. Co,
Milwaukee 1, Wis.

Please send my copy of Car Shaker Bulletin 07B7221A.

Name .....

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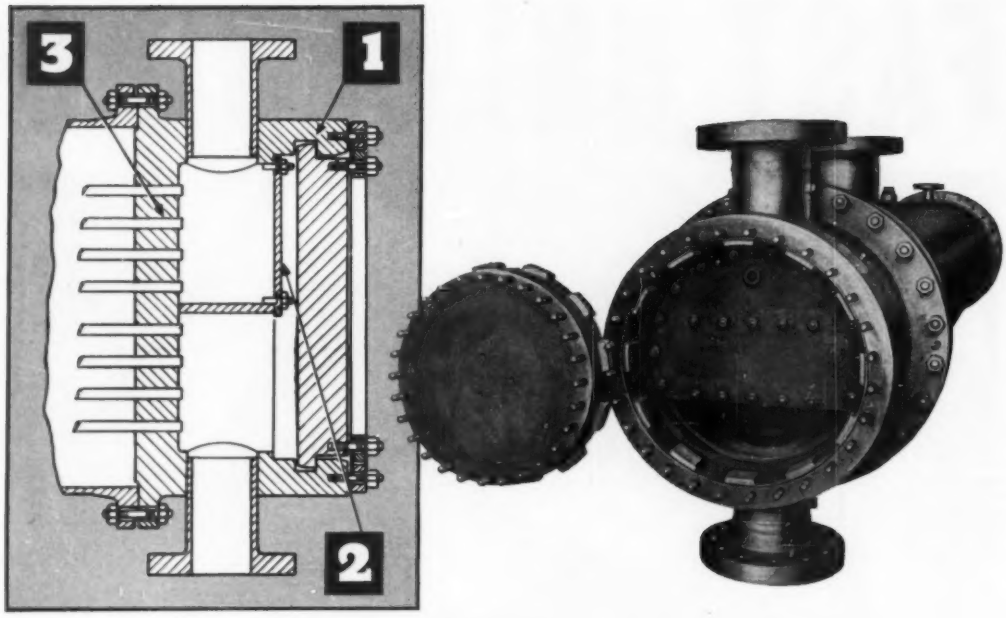
A-3648



Your 3 WAY protection against leakage in this G-R Feedwater Heater

1 At the water head covers

You know how the barrel and breech block in big guns are locked by lugs or projections. The same effective closure principle assures complete tightness for the water head covers of G-R High-Pressure Feedwater Heaters. In these units, interlocking lugs carry the hydraulic load . . . therefore no need for the large number of heavy bolts required by other high pressure heater designs.

2 At the pass partitions

Here's a fruitful source of leakage that can't even be detected in many designs of feedwater heaters. You'll have no worry on that score with G-R Feedwater Heaters, because in these units the differential in water pressure between passes helps to keep the partition joints *tight* instead of tending to force them apart. The sketch tells the story.

3 At the tube sheet joints

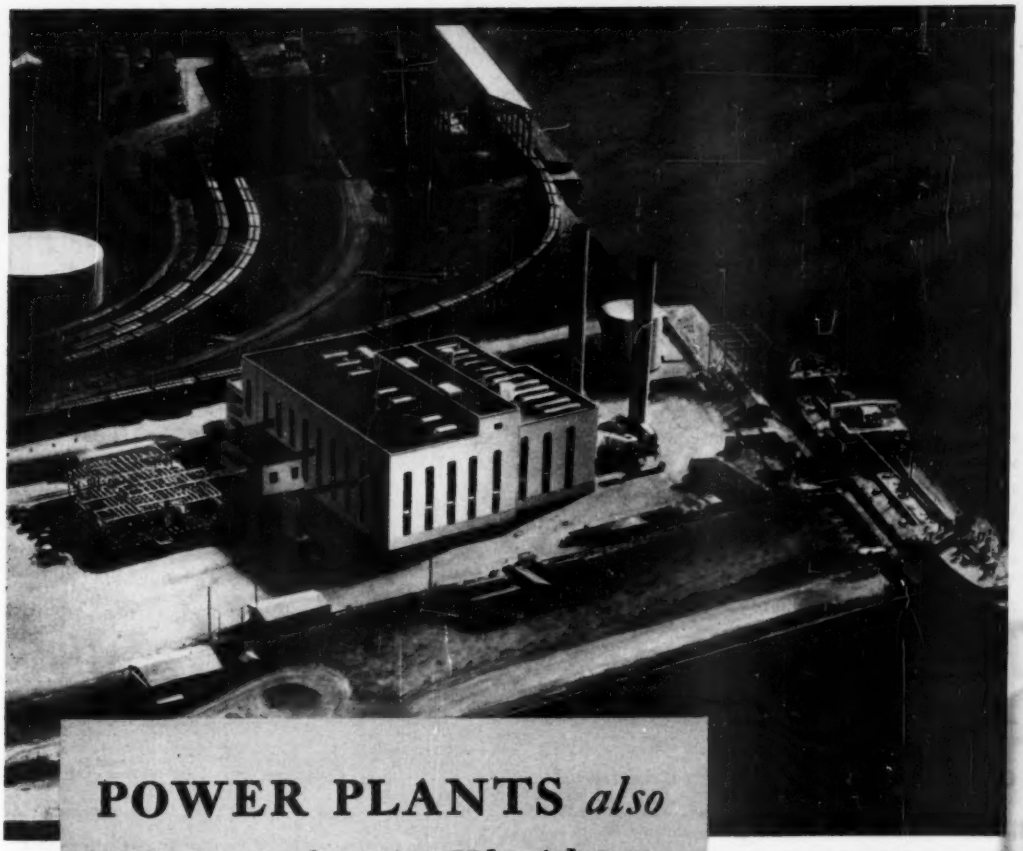
83 Years of experience in building heat transfer apparatus have taught G-R how to make tube sheet joints *lastingly* tight. This unequalled experience . . . based on the results obtained in many hundreds of thousands of installed units . . . is your assurance of uniformly thorough tightness of all tube ends in every tube sheet.

Write for bulletin describing G-R Feedwater Heaters in detail.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

GRISCOM-RUSSELL

FIONEERS IN HEAT TRANSFER APPARATUS



POWER PLANTS *also grow fast in Florida*

The Hookers Point Station of the Tampa Electric Company, located on the Sparkman Channel, near the southeastern limit of the city. The first 30,000 kw capacity was completed in 1948.

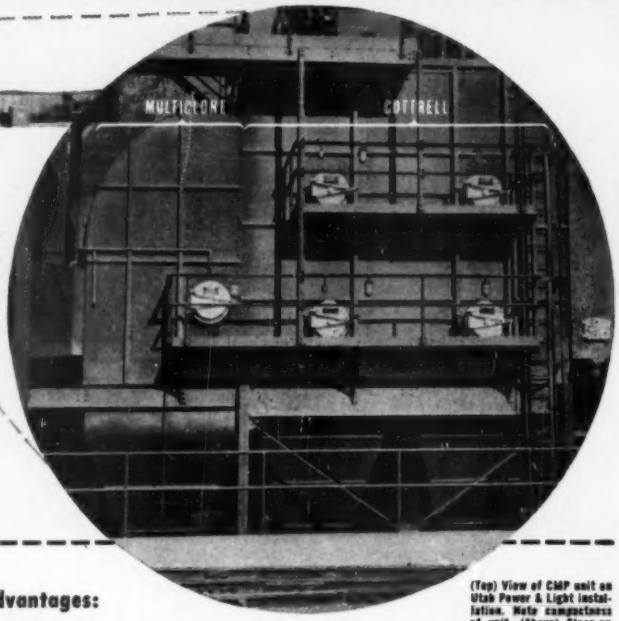
THE 30,000 kw capacity of Tampa Electric Company's Hookers Point Station, designed and constructed by Stone & Webster Engineering Corporation, was tripled in 1950 with the completion of a 60,000 kw extension. A further expansion, now under way, will raise the name-plate capacity of the station to 130,000 kw.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

Planning A Fly Ash Recovery Installation?

Consider these important advantages of a WESTERN PRECIPITATION CMP UNIT!



IF YOU are planning the installation of any type of fly ash recovery equipment—mechanical or electrical—it will pay you to investigate the extra advantages to be gained by installing a CMP Unit designed, engineered and constructed under *one* responsibility by Western Precipitation Corporation—*leaders in both electrical and mechanical recovery fields!*

(Top) View of CMP unit on Utah Power & Light installation. Note compactness of unit. (Above) Close-up of same installation.

Combines Mechanical and Electrical Advantages:

A CMP (Combination Multiclone-Cottrell Precipitator) Unit combines—in one compact installation—both mechanical and electrical recovery principles, so that maximum benefit is obtained from the advantages inherent in each method. The MULTICLONE section centrifugally cleans the gases of the larger and heavier fly ash particles (down to a few microns in diameter) . . . and the COTTRELL Precipitator then electrically removes the very small particles remaining in the gases. This combination arrangement has important advantages:

1. Using the MULTICLONE for cleaning out the heavier particles permits the bulk of the recovery operation to be performed with relatively low-cost equipment.

2. Using the COTTRELL for final clean-up insures unusually high recovery efficiency—approaching theoretically perfect, if desired—with a high efficiency, compact Precipitator unit.

3. Each type of unit—MULTICLONE and COTTRELL—can be arranged for its most efficient application. MULTICLONES may be connected to each separate boiler, if desired, and their draft requirement cut out when the boiler is down . . . while a central COTTRELL handles all gases and operates at higher efficiencies, with continued low power cost, when one or more boilers are down.

4. During soot-blowing periods, or while warming up cold boilers, the MULTICLONE efficiency usually increases, preventing overloads of detrimental carbon from reaching the COTTRELL.

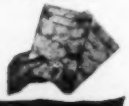
Only Western Precipitation Combines Multiclone and Cottrell "Know-How"—In ONE Organization!

A vital factor in obtaining maximum efficiency and economy in CMP installations is the proper balance of mechanical and electrical recovery equipment to the individual requirements of *each* application. Western Precipitation is unique in that it not only pioneered the commercial application of COTTRELL Electrical Precipitators over 43 years ago, but also has been a leader for many years in the *mechanical* recovery field with its widely-recognized MULTICLONE Collectors.

Result—Western Precipitation has the all-important "know-how" and experience in BOTH fields . . . knows from first-hand experience how to fit the *right* equipment in the *right* place, to do *your particular* job . . . and can provide the complete installation under ONE responsibility and ONE overall guarantee!

Let Our Experienced Engineers study your recovery requirements and make recommendations on the equipment best suited to your operations. A wire, phone call or letter to our nearest office places this unique "Know-How" at your service, without obligation!

Send for descriptive literature!

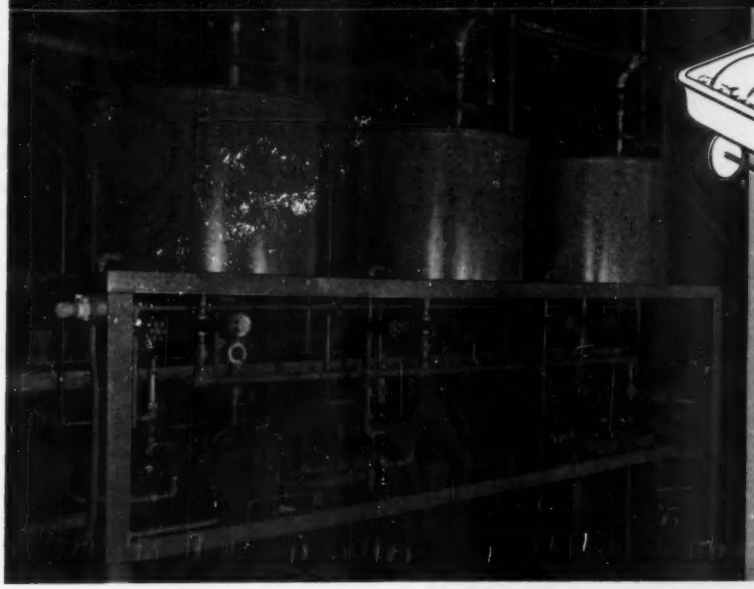


WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1029 WEST NINTH STREET, LOS ANGELES 16, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 LaSALLE ST. BLDG., 1 N. La SALLE ST., CHICAGO 2 • HOBART BUILDING, SAN FRANCISCO 4, CALIFORNIA
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

WATER FOR TRIPLE BOILERS INDIVIDUALLY TREATED BY SINGLE PACKAGE



Assembly includes 3 Model SHPM Adjust-O-Feeders — Capacity 7.8 GPH against 225 psig — handling phosphate and sulfite solutions.

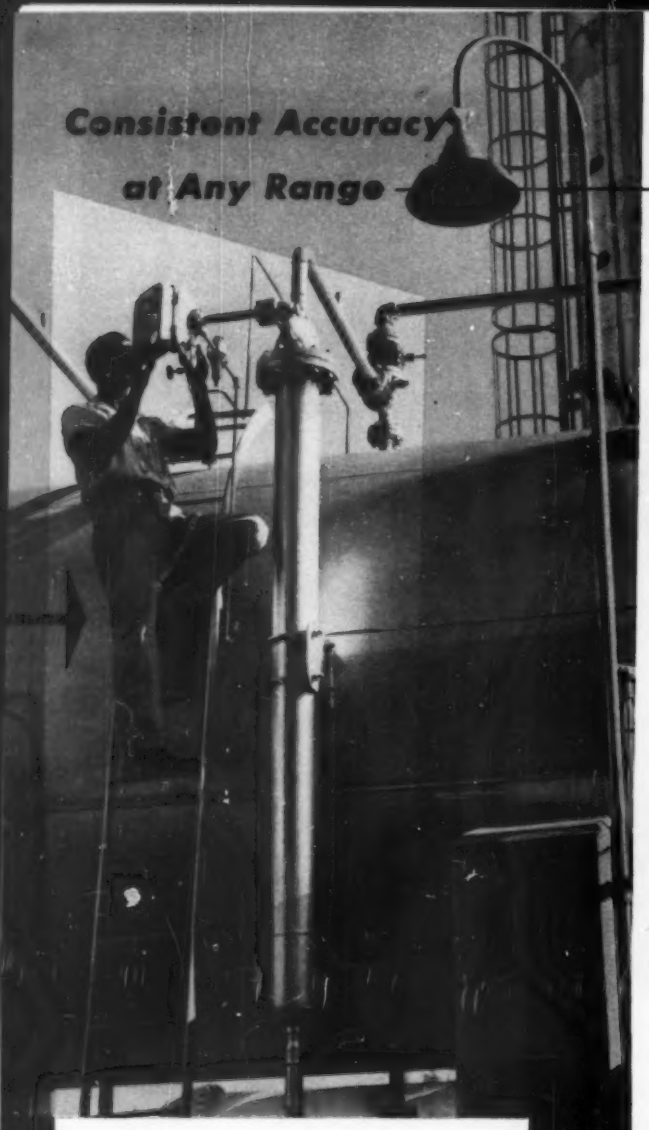
This %Proportioneers, Inc.% packaged system includes metering pumps, chemical tanks, motor starters, controls, valves, piping, and all auxiliary equipment — compactly arranged as a single unit. Treating chemicals are fed automatically in proportion to service load on each boiler. This "Triplet Package" is supplied complete — a single responsibility for your chemical feeding system. We can also supply systems for treating one, two—or *any* number of boilers: chemical feeding systems for any power plant from the largest high pressure installation to the smallest low pressure job. For recommendations call in %Proportioneers, Inc.%.

Write for Brochure SM 9020
"Treatment of Water for Boilers" and Bulletin CAT.

%PROPORTIONEERS, INC.%

Write to %PROPORTIONEERS, INC.%, 385 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.



BS&B

CLIMAX

LIQUID LEVEL CONTROL

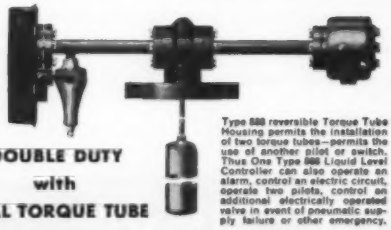
TYPE 888

Any level control is accurate when first set—but BS&B's new Climax Type 888 Liquid Level Controls are **consistently** accurate! Whether the liquid level range is ¼" or 120"—the CONE PIVOT suspension point of the new Climax 888 is friction free—largely self-compensating for misalignment—does away with the sticking action of outboard bearings or the climbing of knife edges.

To inspect or replace the cone point—external positioning makes the job a matter of minutes.

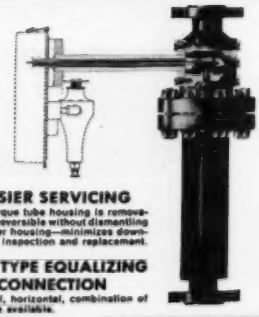
TYPE 888 TORQUE TUBE is stronger, heavier and made of INCONEL—the material found most corrosion resistant under torsion stresses. (Other alloys available in stock for special conditions.) The torque tube shaft is rigidly centered by a friction-free ball bearing.

HEAVY TORQUE TUBE helps provide longer life—permits the employment of heavier displacement elements with high safety factor and wider gravity range application.



DOUBLE DUTY with DUAL TORQUE TUBE

Type 888 reversible Torque Tube Housing permits the installation of two torque tubes—permits the use of another pilot or switch. Thus One Type 888 Liquid Level Controller can also operate an alarm, control an electric circuit, operate two pilots, control an additional electrically operated valve in event of pneumatic supply failure or other emergency.



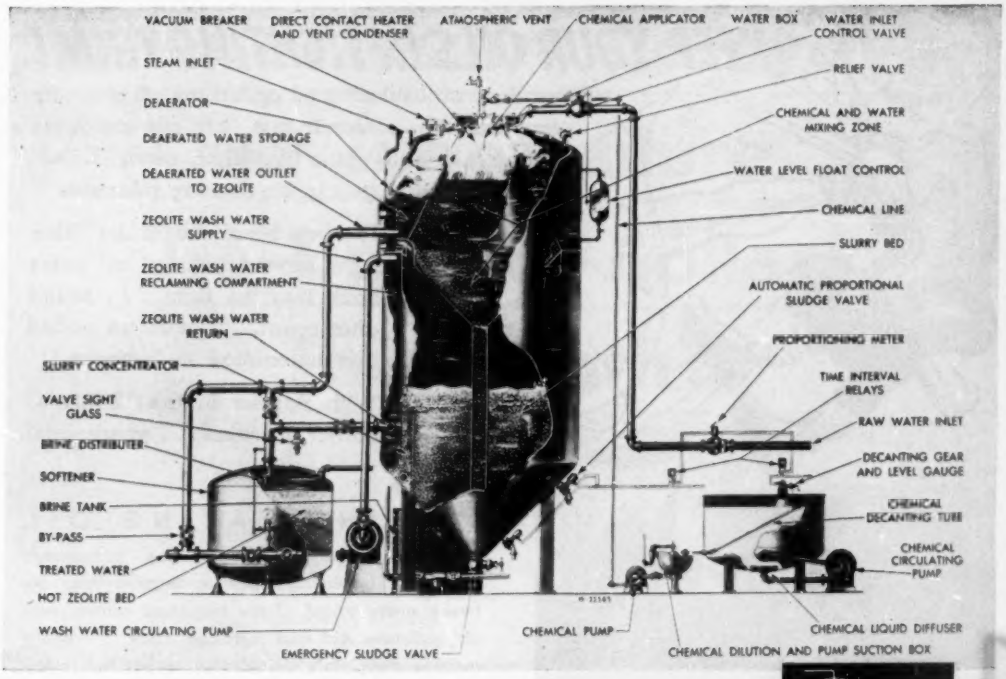
EASIER SERVICING
—the torque tube housing is removable and reversible without dismantling controller housing—minimizes down-time for inspection and replacement.

ANY TYPE EQUALIZING CONNECTION
—vertical, horizontal, combination of both, are available.

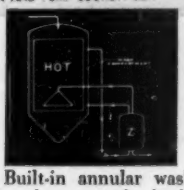
CLIMAX BS&B CONTROLS

WRITE TODAY FOR NEW, COMPLETE CLIMAX SECTION 103 CATALOG (TYPE 888 LIQUID LEVEL CONTROLLER)

BLACK, SIVALLS & BRYSON, INC.
CLIMAX CONTROLS DIVISION, DEPT. 61-K
7500 E. 12TH, KANSAS CITY 3, MO.



Here's how to make water softening a soft job for you



You have less to do . . . to worry about . . . to pay for—when you use Worthington's revolutionary Hot-Z Slurry-Type Deaerating Water Softener.

It combines all the best features of Hot Process and Zeolite, plus these Worthington-originated features:

No more scaling trouble. Direct-contact vent condenser eliminates scaling trouble experienced with old-fashioned shell-and-tube types.

Supervision reduced. Concentrated sludge is removed automatically and proportionately to water volume.

Assures uniformity. Hydraulic chemical mixer assures uniformity of chemical strength. Also saves space.

Easier cleaning of valve-type wash water sight glass.

Better deaeration. Steam-jet deaeration is simpler, gives better efficiency—removes oxygen to .005 cc per litre.

Independent backwash system. Built-in annular wash water compartment provides clear hot water for backwashing and reclaims it without affecting operating velocities in treating zone. This feature not only pays off in systems employing filters, but also is ideal for backwashing the hot zeolite.

You also save because Worthington Hot-Z Systems operate on low-priced lime and salt. The average installation saves enough in chemical costs to pay for itself in 3 years!

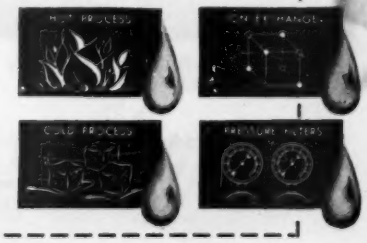
Get all the facts!

It will pay you to investigate the Worthington Hot-Z System thoroughly. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find *there's more worth in Worthington.* Worthington Pump and Machinery Corporation, Water Treating Section, Dunnellen, N. J.

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



KEEP YOUR OILS IN FIGHTING TRIM!

Every drop of insulating oil or turbine oil is a constant target for contaminants. Both oils are game fighters, but they don't last long when "Killer" contaminant gets in his Sunday punches.

The best break the "Killer" likes is to have "Battling" oil come back into the fight . . . round after round . . . with no period of rejuvenation in between.

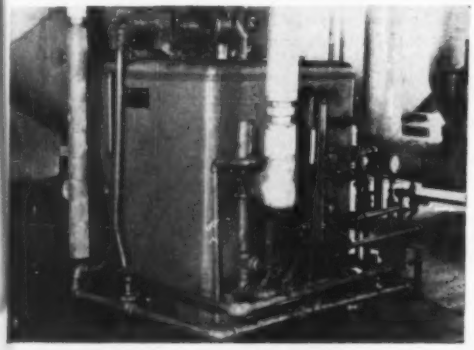
With Bowser in the "Battler's" corner, he wins . . . every time!

Portable Bowser insulating oil conditioning unit for transformers, circuit breakers and switches.

INSULATING OIL

Bowser conditioners keep transformer insulating oil in top fighting form. Between every round of the perpetual contest with air, moisture, dirt and corrosive acids . . . every drop is completely dehydrated, degasified, stabilized and cleaned.

Oil dielectric is restored above 35 k.v. in a single pass and transformers remain energized during the process. Less standby equipment is needed . . . one man and a truck-mounted conditioner can maintain a widespread substation system.



Bowser turbine oil conditioner serving a 52,000 c.f.m. turbo-blower

TURBINE OIL

Turbine oils have to put up an especially tough fight against these 8 "killers" . . .

Turbulence	Metallic Contact
Air Entrainment	Inhibitor Removal
Moisture Contact	Fly-ash
Heat	Dust

None of them has a chance when a Bowser turbine oil conditioner is on the job. Costly shutdowns are avoided . . . bearings last indefinitely.

A new Bowser booklet that tells all . . . shows all . . . is yours for the asking. Write to Bowser, Inc., 1351 Creighton Avenue, Fort Wayne 2, Indiana

BOWSER ESTABLISHED 1885

LIQUID CONTROL SPECIALISTS SINCE 1885

Will Corrosion, Carryover or Tube Failure Tie-Up Your Boilers This Month?

Whether you operate high or low pressure boilers . . . corrosion, carryover and tube failures are mighty expensive . . . not only in tube replacement and installation costs, but in loss of valuable production time.

These photomicrographs show how proper treatment can reduce tube failures.

On this tube from a high pressure boiler, iron oxide particles have deposited as magnetic iron oxide "scale." Even when distilled make-up is used, this type of deposit frequently occurs, causing tube failure. Although the conventional alkali-phosphate-organic treatment was used, it did not prevent deposits from adhering.

This is a tube operating under similar conditions except that the boiler water has been treated with Drew Complete Boiler Water Treatment. This treatment chemically alters iron oxides—and other types of deposit formations. It makes them non-adherent and eliminates costly tube failure.

Send for new DREW ORGANICS *folder describing the use of organics in modern boiler water treatment. Write today.*

Whether you operate high or low pressure boilers . . . whether your tube failures are caused by iron oxides or any other type of deposit . . . you'll find that Drew can provide a practical, economical solution to your water conditioning problems. Thoroughness of investigation, proper treatment and frequent service have made Drew one of America's fastest growing water treatment companies.

POWER DREW CHEMICALS

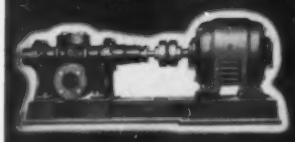
Power Chemicals Division

E. F. DREW & CO., INC.

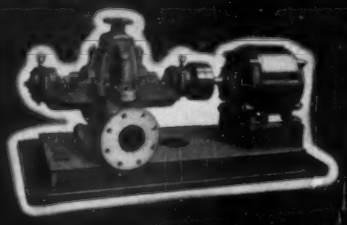
15 East 26th Street, New York 10, N. Y.

Nationwide Service in Boiler Water and Cooling Water Conditioning

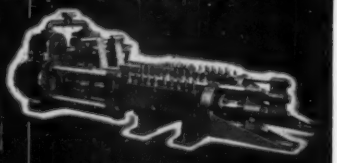
DREW PRODUCTS



Warren-Quimby
Gear-in head Screw Pump



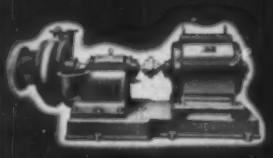
Warren Condensate Pump



Warren Horizontal Duplex
Hydraulic Pump

WARREN PUMPS

Maintain efficiency • Operate at low cost • Are long-lived



Warren Type "L" Single-Stage
Single-Suction Liquor Pump

CENTRIFUGAL

Single and Multi-stage
Pressure range: Up to 1200 P. S. I.
Capacities: Up to 50,000 G. P. M.
Types: Horizontal and Vertical
Impellers: Open or Enclosed

RECIPROCATING

Horizontal and Vertical Single Piston
Horizontal and Vertical Duplex Piston
Single and Duplex Outside Packed Plunger
Single, Duplex and Compound Hydraulic
Steam Heat Vacuum
Automatic Pump and Receiver, etc., etc.,

WARREN-QUIMBY SCREW PUMPS

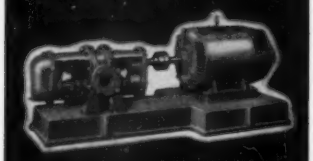
Gear-in-head and External Gear and Bearing
Capacities: Up to 3000 G. P. M.
Pressures: Up to 200 P. S. I. on low viscosity liquids; practically unlimited on high viscosity liquids
Horizontal or Vertical Mounting

WARREN-QUIMBY ROTARY PUMPS

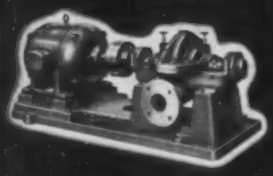
Gear-in-head and External Gear and Bearing
Capacities: Up to 1000 G. P. M.
Pressures: Up to 250 P. S. I.
Horizontal or Vertical Mounted

Send your pumping problem to us; Warren Engineers will recommend the right pump for the job.

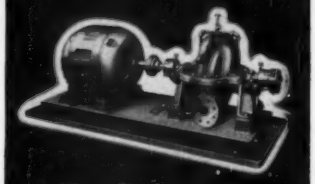
P-25



Warren-Quimby External Gear
and Bearing Rotex Pump



Warren Type DBL, Single-Stage
Double Suction, Centrifugal Pump

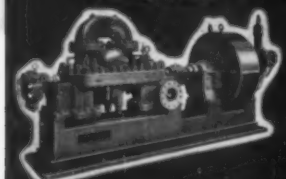


Warren Two-Stage Volute
Centrifugal Pump

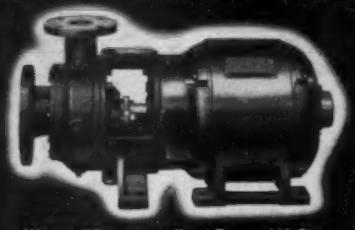
WARREN QUIMBY PUMPS

WARREN STEAM PUMP COMPANY, INC.

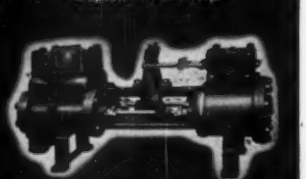
WARREN, MASSACHUSETTS



Warren 4- and 6-Stage
Centrifugal Pumps



Warren "Compacunit"—4 Types—42 Sizes



Warren Horizontal "Realwear"
Duplex Piston Pump

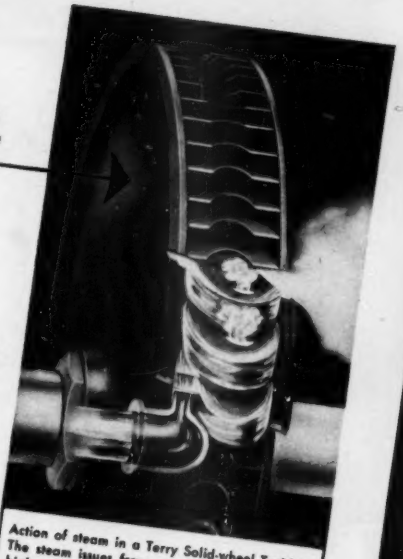
TERRY

THIS TURBINE WHEEL

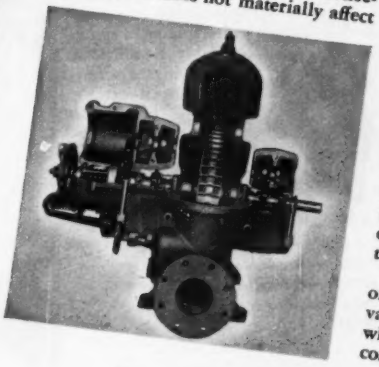
has no parts to loosen or work out

The rotor of the Terry Solid-wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Hence, wear of the blades is of little consequence, as it does not materially affect horsepower or efficiency. There is practically no end thrust since the steam enters and leaves the wheel in a direction at right angles to shaft.



Action of steam in a Terry Solid-wheel Turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.



This is only a small part of the story of the many advantages of the Terry Solid-wheel Turbine. Write for complete details.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1189

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

ONLY COCHRANE ZEOLITE SOFTENERS and FILTERS have the HYDROMATIC SINGLE CONTROL VALVE

Below is shown a Hydromatic Valve arranged for automatic operation.

ONE important feature of Cochrane Zeolite Softeners and Filters is the Hydromatic Single Control Valve replacing the usual "valve nest" or rotary disc single control valves of other equipment. It has the following advantages:

1. It is pilot-operated . . . easy to operate.
2. Soft, single-seated individual valves insure drop-tightness.
3. Six positions—four normal, one shut-off, one for draining.
4. Individual valves easily accessible and replaceable.
5. Automatic and adjustable backwash and rinse controls eliminate need for concrete sumps.

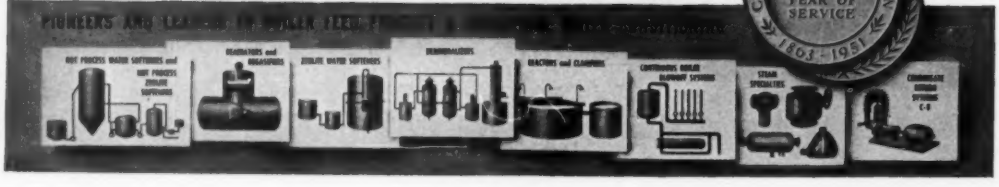
Exploded view of Hydromatic Valve with Front Distributor detached showing detail of valve.

Write for a copy of this 32-page publication (No. 4520) describing not only the Cochrane Hydromatic Single Control Valve, but also, in complete detail, the Cochrane Sodium Zeolite Softener. A separate publication (No. 4530) describes Cochrane Hydrogen Zeolite Softeners. Mention which type you are interested in.

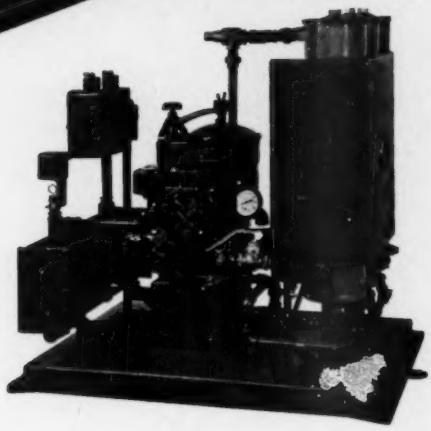
COCHRANE CORPORATION
3123 N. 17th Street, Philadelphia 32, Pa.
In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Babcock & Wilcox de Mexico: S. A. Mexico City
In Europe: Recuperation Thermique & Epuration: Paris

In Canada: Canadian General Electric Co., Ltd., Toronto • In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City • In Europe: Recuperation Thermique & Epuration, Paris

COCHRANE



"PURI-FILTERED" OIL [illegible] CLEAN
YOU CAN READ [illegible] THROUGH IT!



Diesel lubricating oil that has been cleaned by a De Laval "Puri-Filter" is so clean that you can read a book through a test tube full. The oil is ***visibly*** clean — no dirt . . . no water . . . no colloidal carbon!

The "Puri-Filter" cleans oil two ways: (1) by centrifugal force, (2) by micronic filtration. First the De Laval centrifuge removes solid impurities and water, storing the dirt in the bowl of the machine and continuously discharging the water to waste. Then the lubricant is further purified by means of the filters which remove the specks of carbon that are lighter than the oil itself. You ***know*** that the oil going back to the crank case is clean.

De Laval "Puri-Filters" are complete, ready-to-run units. They are available in various capacities.

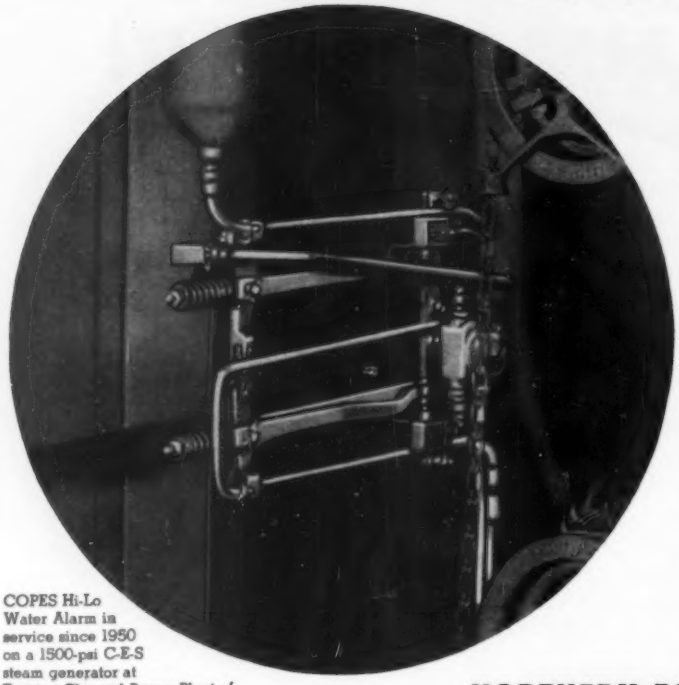
THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL

COPES Hi-Lo WATER ALARM

as simple and dependable as the COPES expansion tube



COPES Hi-Lo Water Alarm in service since 1950 on a 1500-psi C-E-S steam generator at Trenton Channel Power Plant of The Detroit Edison Company.

HERE'S a new Hi-Lo Water Alarm, based on exactly the same established principle that has made the COPES Feed Water Regulator so successful for the last fifty years. On both stationary and marine boilers, it gives trouble free dependability at all working steam pressures. Simple, foolproof and maintenance-free. Compact and self-contained. Easily installed without special supports or complicated piping—with or without a water column. Bulletin 493 tells the full story. Write for it.

NORTHERN EQUIPMENT DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
1212 GROVE DRIVE • ERIE, PENNSYLVANIA

The COPES Hi-Lo Alarm uses no bellows, no diaphragms, no weights, no floats, no differential pressure devices. It has no internal parts to corrode or wear. Standard audible signal is a horn; standard visible signal, lights. Other types of signal can be furnished as desired.

ENGINEERED BY THE MAKERS OF COPES FEED WATER REGULATORS

You will find Raybestos-Manhattan packings and gaskets in machines like this reciprocating boiler-feed pump, and in practically every other type of fluid-handling equipment in industry. The long line of R/M packings and gaskets is relied on by experienced engineers, not only for pumps, but for valves, compressors, expansion joints, hydraulic rams, and wherever trouble-free service is essential. The R/M distributor near you will gladly help you select the right packing or gasket for your needs. Or write for the R/M Packing Catalog.

R/M

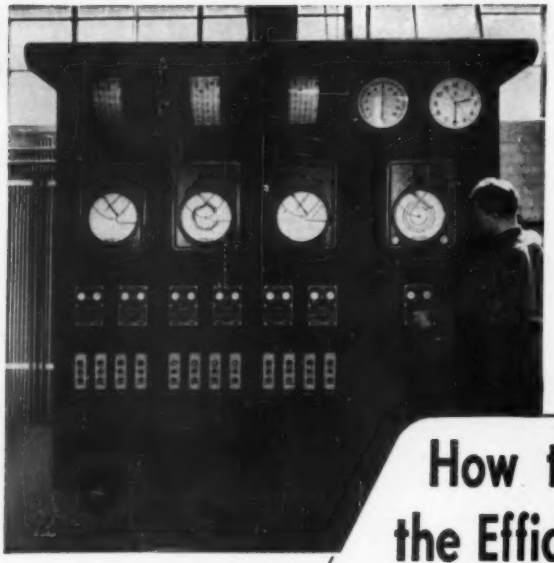
PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn. Manheim, Pa.
No. Charleston, S.C. Passaic, N.J.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls



These Bailey Boiler Controls at the Chicago Pneumatic Tool Company's new plant in Utica, N. Y. insure efficient operation of three 25,000 lb per hour, 100 psi, spreader stoker-fired boilers

How to INCREASE the Efficiency of YOUR BOILER-ROOM DOLLAR

Before you get steam you've got to spend dollars—so dollars are a form of energy.

And if your boiler-room dollars are invested in equipment that isn't working efficiently, economically, your "investment" is poor.

That's where co-ordinated controls by Bailey can help. Here's why they'll increase your "boiler-room investment efficiency":

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service — conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

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For better "boiler-room investment" efficiency —for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

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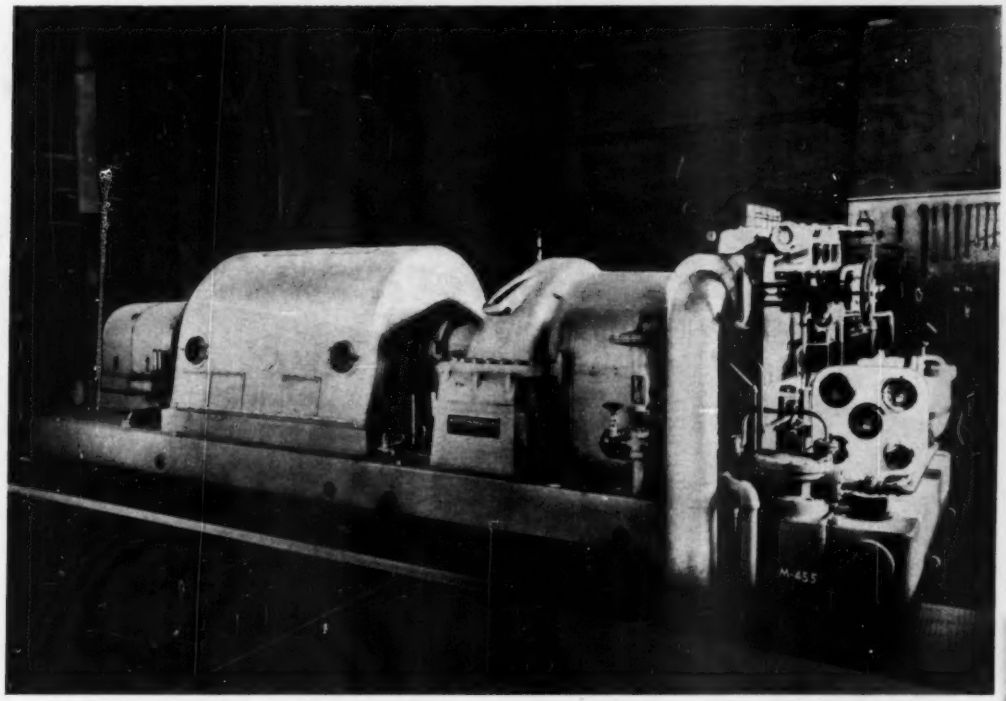
Controls for Steam Plants



Power Planning—for the Years Ahead

Worthington Turbine Generators for Two Harbors Power Plant

This is how the City of Two Harbors, Minnesota met expanding power and light requirements and found the answer to economical power plant operation.

In 1948 the city installed a Worthington 2500-kw turbine generator. This machine operates in parallel with other units already installed in the power plant.

As the electrical demand grew, a survey showed that another power-producing unit was needed. Again, a Worthington turbine generator was selected. The new 3500-kw Worthington unit, to be installed next year, will supplement the existing power plant equipment. With this latest addition, the City of Two Harbors will be fully equipped to handle all its power and light needs for many years to come.

Worthington builds steam turbines in all types and sizes—and turbine-generator sets up to 10,000 kw. For proof *there's more worth in Worthington*, call our nearest office or write to Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.

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STEAM TURBINE GENERATORS

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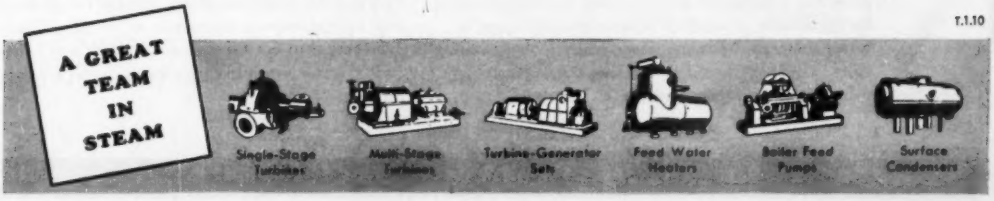
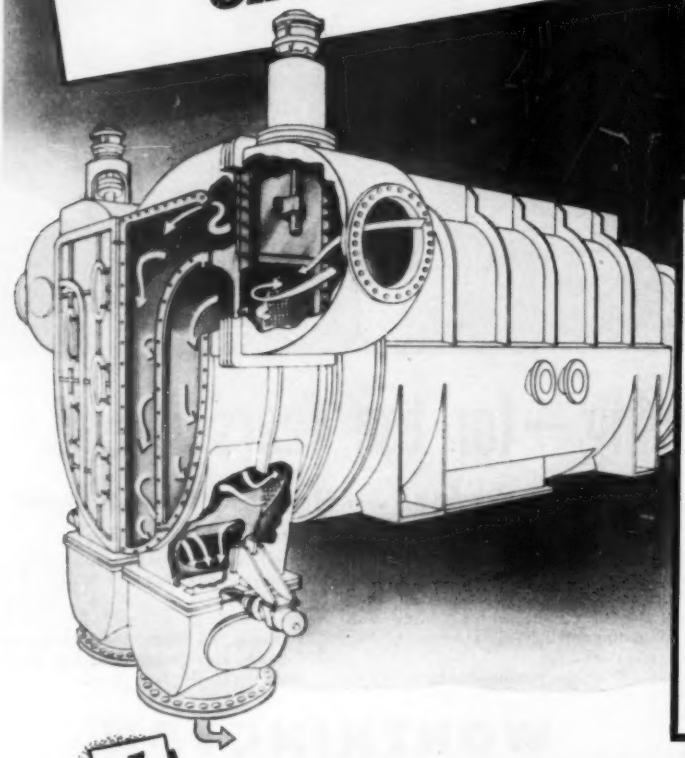
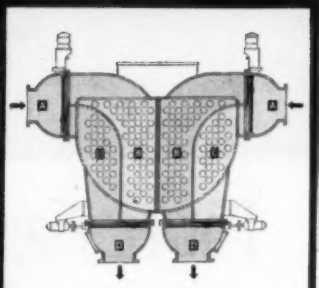


Here's a 3-WAY "ASSIST" On Your Power Plant Problems





HERE IS HOW REVERSE FLOW WORKS

Reverse flow sluice gates on divided water box condensers work the same in both halves but independently of each other. Right side: normal flow. Water enters divided water box in valve chamber "A" with lower port open. It flows through pass "C" to end of condenser, back through pass "B" and out through left port of "D."

Left side: flow is reversed. Valves at inlet "A" and discharge "D" are changed to permit water to flow through "B" and back through "C" in the opposite direction and then out through the left port of "D."

1 CLEAN DEBRIS FROM CONDENSER TUBE SHEETS WITHOUT DOWNTIME OR LOSS OF VACUUM

C. H. Wheeler "Reverse Flow" Condenser design provides a powerful self-cleaning flushing force by the simple procedure of reversing the flow of water through the tubes. Electrically or hydraulically controlled sluice gates accomplish in minutes cleaning that consumes hours of downtime when removal of debris is done by hand. Power plant modernization calls for the efficiency and uninterrupted operation of C. H. Wheeler "Reverse Flow" Condensers. You don't need costly water straining apparatus. Send for latest bulletin #410.

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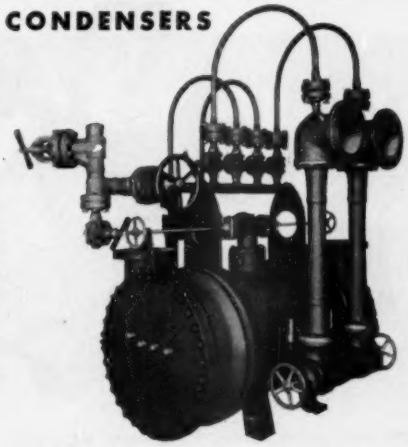
2 VACUUM PUMPS WITH LOWEST MAINTENANCE FOR YOUR STEAM CONDENSERS

C. H. Wheeler Steam Jet Ejectors are the development of 35 years of pioneering in this field. Known as "Tubejets," these vacuum pumps have no moving parts. Hence, they are simple to operate, require almost no maintenance and last longer. Modern Power plants use single or two-stage Tubejets with surface inter-after condenser for the vacuum requirements of steam condensers. Special arrangements of standard Wheeler ejector assemblies can be provided for any unusual installation or performance requirements. Catalog #1462 gives you detailed descriptions and some useful temperature and pressure conversion tables. Write for it.



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DEAERATOR HEAT BALANCE

(Continued from page 75)

Step 3. Divide the perpendicular distance between the origin and the line AB in 10 equal spaces, draw reference lines for heater output of 270,000 lb per hr, 240,000 lb per hr, etc.

Step 4. Obtain the point C, its distance from the origin corresponding to the make-up flow of $kx\frac{bc}{a(b+c)}$.

$$OC = 300{,}000 \times \frac{48.3 \times 960.1}{168.14 \times 1008.4} = 82{,}051 \text{ lb per hr}$$

and draw the connecting line from C to B.

Step 5. Determine the steam flows required to develop rated capacity with maximum make-up flow only, and with maximum condensate flow only, respectively, as to be:

Min steam flow: 300,000 − 285,630 = 14,370 lb per hr

Max steam flow: 300,000 − 255,291 = 44,709 lb per hr

Connect A and B by a straight line, draw the inclined scale for steam from zero to 44,709 lb per hr in point A, and calibrate the line AB by means of the inclined scale.

The heater state triangle as obtained yields solutions to all questions arising in heat balance computations, the sizing of auxiliary equipment to the heater as pipe lines, relief valves, steam admission valves etc.

Three typical examples with reference to Fig. 2 are presented for the typical heater, analyzed in the foregoing.

Example I. Having 90,000 lb per hr of make-up water available, determine the condensate flow and steam flow required to produce rated feedwater output.

Solution I. Draw lines 1–2, 2–3 and read from scales

25,000 lb per hr of steam
185,000 lb per hr of condensate

Example II. Having 160,000 lb per hr of condensate available, how much steam and make-up are required to produce 255,000 lb per hr of feedwater?

Solution II. Draw lines 5–6, 6–7 and read from scales

74,000 lb per hr of make-up
21,000 lb per hr of steam

Example III. Having 25,000 lb per hr of steam available from auxiliaries, how much condensate and make-up are required to produce 225,000 lb per hr of feedwater?

Solution III. Draw lines 9–10, 9–11, and read from scales

81,700 lb per hr of condensate
118,300 lb per hr of make-up

Example IV. What fractional capacity will be developed by the heater, when operated under conditions represented by point C?

Solution IV. The make-up flow of

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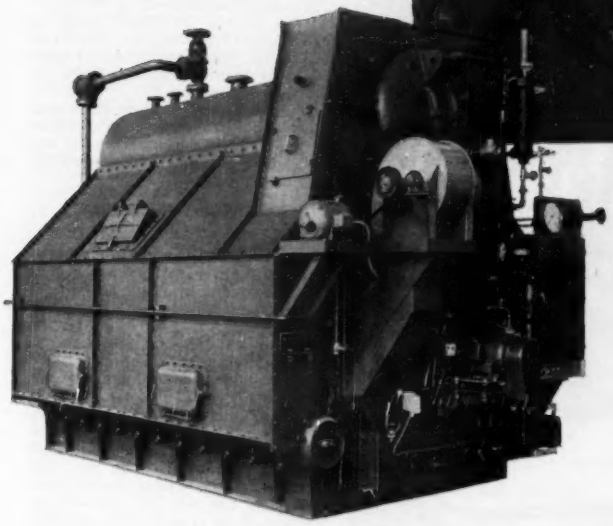
shop assembled power

FOR YOUR STEAM GENERATING NEEDS



Steam power in a compact, efficient shop-assembled unit, custom-engineered to your exact steam generating requirements, ready for immediate installation! Wickes Type A Steam Generator is a steel-encased unit complete with baffles, refractories, pressure parts and firing equipment, designed to conserve headroom and floor space. Each furnace wall is a separate steam generator as well as an integral part of the boiler. There are no complicated headers or circulating tubes to require frequent maintenance or repair. Wickes Type A shop-assembled boilers are engineered for pressures up to 900 psi. with sustained steam production up to 35,000 lbs. per hour at 20 to 330 nominal h.p.

Wickes can also fill your requirements for steam generators up to 250,000 lbs. per hour and 950 psi. — all types of multiple drum boilers adaptable to any standard method of firing, oil, gas, single retort underfeed or spreader stoker. Write today for descriptive literature on Wickes complete line of steam generating equipment or consult your nearest Wickes representative.

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SAGINAW, MICHIGAN

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82,051 lb per hr, computed in Step 4, is capable of absorbing 14,370 lb per hr of steam. Therefore, the fractional capacity at point C is

$$\frac{82{,}051 + 14{,}370}{300{,}000} = 32.14 \text{ per cent}$$

Sometimes heater specifications include conditions limiting the flow of one, two or all constituents, admitted to the heater. Conditions of this kind do not affect the procedure of obtaining the basic heater state triangle, outlined in the foregoing.

In the case of the assumed heater, for instance, the specification may require the steam flow not to exceed 35,000 lb per hr, the reason being that no larger steam flow can be made available from the auxiliaries.

For this case, the heater state triangle may be obtained in the normal way, disregarding completely the limiting conditions imposed by the specification. Due to the limited range of the heater, however, no operation can occur under conditions represented by points located beyond the 35,000 lb steam line, FG.

Therefore, only straight lines and intersections can be considered within the area OGFB, representing the actual entire range of the specified heater operation.

ATOMIC POWER PLANT

(Continued from page 72)

the results with the operating costs of fuel-fired plants. In all such cases the high cost of the uranium has been a vital limiting factor in appraising the overall feasibility of such plants. Uranium is a scarce material and the cost, understandably, is high.

If, however, reactors can be built which will generate power while at the same time producing fissionable material, then the element of uranium cost disappears. The fissionable materials will have to be produced regardless of the type of reactor used. At present the very low temperature reactors of the type installed at Hanford are used. The heat, that is, the power developed, is thrown away. By raising the temperature, however, the power can be utilized. Since no more uranium is used, the uranium cost remains the same.

It is conceivable, therefore, that in the years to come, we will see power plants built by private interests consisting of low or moderate temperature reactors from which power can be recovered for general commercial use, and at the same time, the fissionable material would go to the military. Such plants would, of course, be built and operated under the supervision of the Atomic Energy Commission. The Commission would supply the fuel, that is, the uranium, or thorium, if the breeder idea proves successful and, of course, the Commission also would receive the fissionable material produced. The power company would sell the power. Such combination plants would supply increasingly large amounts of the country's power. The thermal effi-

ciency of these plants would be of far less importance than their nuclear efficiency, i.e., the ratio of fissionable material output to raw material input.

A very important factor in the future development of atomic power is the *breeder* reactor. As carried on at present in the Hanford reactors, the fission of U-235 nuclei results in the formation of plutonium nuclei (Pu-239). The maximum rate of plutonium production is, therefore, dependent upon the amount of U-235 available and also upon the efficiency of production. The amount of U-235 available is not large, being only 0.72 per cent, or about one part in 139, of ordinary uranium. Uranium-235 releases an average of 2.5 neutrons per thermal neutron fission. Only one of these neutrons, on an average, need be effective in converting a U-238 nucleus into plutonium to give a rate of plutonium production equal to the amount of U-235 undergoing fission.

The remaining 1.5 neutrons, provided they are not wasted, could bring about fission in other U-235 nuclei and thus the reaction would be sustained. If no neutrons were wasted, one neutron from each fission would go to sustain the chain reaction and 1.5 could go to the manufacture of 1.5 nuclei of fuel to replace the one *burned*. Theoretically, therefore, breeding is possible, but, so far, in practice such efficiencies have not been attained. An experimental breeder reactor is now being completed at the Reactor Testing Station in Idaho but it probably will be some time before specific data of breeding can be obtained. The high-temperature power breeder reactor, which would utilize substantially all the heat and all the fuel, must be regarded as the logical objective and challenge to the atomic industry in the years immediately ahead.

The successful development of the breeder reactor would greatly increase the amount of fissionable material at our disposal, but whether or not breeding becomes possible, the fact remains that in the conventional production of plutonium, tremendous quantities of heat are evolved and in a properly designed reactor, this heat could be used to produce steam for operating ordinary steam turbines.

Since this heat is a by-product of the production of plutonium, the question of high thermal efficiency is not important, and for this reason it will be expedient to operate the combination material power reactors at moderate temperatures, since the use of high temperatures and pressures would introduce additional difficulties.

It might be argued, that in view of the present high state of development of steam power engineering, utilizing steam pressures up to 2300 psi and temperatures of 1050 F, it would be a retrogression to return to steam plants with pressures of, say, 450 psi and temperatures also around 450 F. In recent years progress in steam en-

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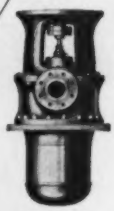
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Pacific Will Specify – The most efficient size and the correct materials.

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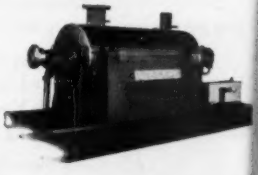
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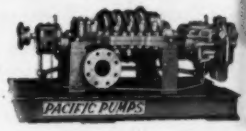

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gineering has been in the direction of smaller, more compact, highly concentrated units, and, so, in reverting to the use of large, low pressure units, we would be, in effect, retracing our steps. However one may feel about this question, the deciding factor will be one of economics, and if it can be shown that in the process of producing fissionable material for military purposes, enormous quantities are available in the form of low level heat, means will be found to utilize them. Once such combination low-pressure plants are established, gradually there will be development toward the design of higher pressure, higher temperature plants, and in time also to the high-temperature, high-pressure breeder reactor plant.

New ENGINEERING BOOKS

Code for Pressure Piping by Section Committee B31, No. ASA B31.11-951; 101 pages; illustrated; size 8½ by 11 in.; cardboard binding; published by The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.; price $3.50. (Order through Publication Sales Dept.)

This is the latest revision of the Code that is accepted throughout the power field as the standard of design and operation of pressure piping.

The book contains all the sections of the Code: — Section 1 — Power Piping; Section 2 — Gas and Air Piping; Section 3 — Oil Piping; Section 4 — District Heating Piping; Section 5 — Refrigeration Piping; and Section 6 — Fabrication Details.

Included with the Code is a separate copy of the Standard Qualification for Welding Procedure and Welding Operator, Section IX, ASME Boiler Construction Code, 1949 Edition.

Internal Combustion Engines, by Lester C. Lichty; Sixth Edition; 598 pages; illustrated; size 6¼ by 9¼ in.; cloth; published by McGraw-Hill Book Company, 330 W. 42nd St., New York 18, N. Y.; price $7.00.

This Sixth Edition of this well-known book is a major revision in which the more difficult parts of the previous edition have been simplified, some of the old and questionable material has been eliminated and considerable new material has been added. Development of the gas turbine, jet and rocket engines has necessitated inclusion of the Lenoir and Brayton cycles, which were not of much interest before the second World War. The air-standard analysis is used to explain all important cycles and there is good discussion of the actual combustion process, using the combustion charts of Hersey, Eberhardt and Hottel.

The book is a very practical treatment of the whole subject and does not require use of higher mathematics for understanding.

It covers the subject in the following chapters: Internal Combustion Engine Process; Thermodynamics for Engine Analysis; The Combustion Process; Air Standard Cycle Analysis; Internal Combustion Engine Process Analysis; Deviations from Ideal Processes; Fuels; Combustion Knock and Knock Rating; Car-

buretion and Fuel Injection Manifolds and Mixture Distribution; Valves and Valve Mechanisms; Ignition of the Charge; Combustion Chamber Design; Engine Lubrication; Heat Transfer and Engine Cooling; Engine Performance; Mechanics of Principal Moving Parts; Engine Vibration and Balance; and Engine Design.

Methods of Analyzing Coal and Coke, by A. C. Fieldner and W. A. Selvig, Bulletin 492; 51 pages; illustrated; size 8½ by 11 in.; paper binding; published by Bureau of Mines, U. S. Department of Interior, obtainable from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; price 50 cents.

This paper, first published in January 1912 as Technical Paper 8, went through various revisions and enlargements to incorporate improvements and modifications in laboratory procedures as well as new methods. The present bulletin includes changes in determination of carbon and hydrogen by means of electrically-heated combustion furnace, methods for determining the agglutinating value of coal and the free-swelling index of coal, and the tumbler test for coke. The Bulletin discusses methods of analysis in detail and should be very helpful to all persons interested or concerned with it.

Report on Oil and Gas Engine Power Costs for 1949, by Subcommittee on Oil and Gas Engine Power Costs, Oil and Gas Power Div., American Society of Mechanical Engineers, H. C. Major, Chairman; 40 pages; size 8½ by 11 in.; paper binding; published by the American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y.; price $2.50.

This is the latest report on this subject from the Committee and its scope has been extended to include operating cost data on dual-fuel and gas engines. Past reports have included a few plants using dual-fuel engines but, because of the format of the report, it was necessary to list certain essential data in the footnotes. In the present report, however, the tables were changed somewhat to provide space for these data, also making it possible to include cost data on spark-ignition gas engines.

This report includes 17 plants with a total of 38 dual-fuel engines and 4 gas engine plants with a total of 10 gas engines. The total number of plants reporting is 122 with a total of 448 engines having total rated bhp of 432,703 bhp and a total output of 683,912,196 kwh.

Unless otherwise noted, as in the above paragraph, the majority of the engines listed in the report are full diesel vertical type, direct-connected to generator. Graphs are given of running plant capacity factors against both lubricating oil and fuel economy, and then the detailed data for each engine one shown in tabular form, followed by another table showing engine details and operating information.

Inspection of Fine-Pitch Gears, AGMA 236.02; ASA B6.11–1951; 36 pages; size 8½ by 11 in.; illustrated; published by the American Society of Mechanical Engineers, 29 W. 39th Street, New York 18 N. Y.; price $2.50.

This new American Standard is sponsored by American Gear Manufacturers Association and the American Society of Mechanical Engineers. It provides the best method for determining before assembly whether or not a mechanism employing gears of 20 diametral pitch and finer will function properly.

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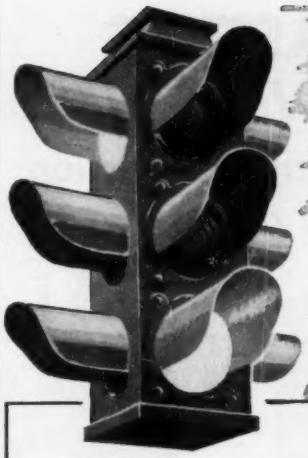

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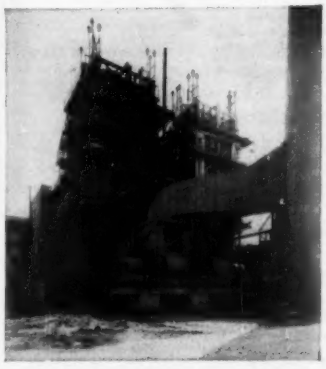
One significant fact about Green Fan Installations at the New Orleans Public Service Plant is that two different boiler manufacturers were involved . . . two different types of boilers but Green Draft Fans for all three boilers. Each boiler has two Green Induced Draft Fans and one Green Forced Draft Fan.

When a concern has specialized on an important piece of power plant equipment for many years, that firm is rightly called the "authority" on the subject. This is the position of Green Fuel Economizer Co. in the field of mechanical draft fans. The name Green is synonymous with Draft Fans highly acceptable to industry.



The Line of Green Induced and Forced Draft Fans includes many types in many sizes which are described in Bulletin No. 168. We shall be glad to discuss your fan requirements with your own engineers, with your consulting engineers and with the boiler manufacturer of your choice.

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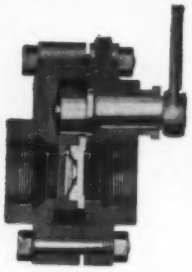
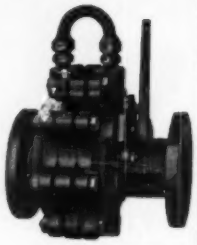
Wherever frequent use and quick operation is required for any liquid or gas at pressures up to 300 psi. These valves have outside stuffing box and gland.





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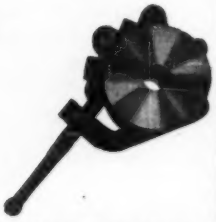

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of obtaining the same information are also described and their uses and limitations defined.

Included are: Specifications for backlash and tolerances, procedures for making comparator layouts and a photographic negative to desired scale, requirements for machining gear blanks, the gear blank terms, tin measurements, directions for using master gears and classifications for various degrees of surface roughness, waviness and for several varieties of lay.

ASH&VE Guide, 1951, 29th edition, 1456 pages; illustrated; size 6 x 9 in.; cloth binding; published by American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York 10, New York; price $7.50.

Like previous editions, this latest edition of the famous ASH&VE Guide contains a technical data section of 1048 pages and a manufacturer's catalog data section filling the rest of the book. Both are completely indexed.

This guide, as every engineer must know by this time, is the standard handbook of the Heating, Ventilating and Air-Conditioning field and is considered to be one of the most authoritative publications in this field. As each edition is issued annually, the Society makes every attempt to bring it completely up to date so it will represent the prevailing approved practice in the field.

In the 29th edition, 24 pages have been added to the technical data section but an even greater quantity of new material was added in space saved by concentration and condensation of previous technical text.

Arrangement of chapters remains the same as in the preceding edition. They are grouped in sections under the headings:

1. Fundamentals; 2. Human reactions; 3. Heating and cooling load; 4. Combustion and consumption of fuels; 5. Systems and equipment; 6. Special systems; 7. Instruments and codes.

Chapter 2 on abbreviations and symbols contains the latest ASA symbols for use on drawings.

A new ASH&VE psychrometric chart has been prepared in large size, included in a pocket on the inside back cover. Illustrations and problems are given to show how the chart is used, and the chapter on thermodynamics has been rewritten and simplified. Other changes have been made in the chapters on fluid flow and heat transfer, the latter being greatly enlarged.

The book is filled with good clear drawings and schematic diagrams; and the necessary tables of data on various factors are inserted, in most cases, close to the text referring to them.

Like all previous editions, the guide is an indispensable help for any engineer who has to solve heating and air-conditioning problems. It is hard to see how he could get along without it.

The Behavior of Engineering Metals, by H. W. Gillett. Size 6 by 9 in.; 395 pp including index; cloth bound. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; price $6.50.

The book begins with an introduction to the basic concepts of metallurgy and goes on to deal, in order of commercial importance, with each of the major engineering metals and alloys.

The author emphasizes behavior of these materials, rather than theories which explain behavior. The rest of the book is devoted to special considerations that may influence selection, such as machinability, special fabricating techniques, corrosion and temperature protection.

Discussion of surface stress; wrought steels of intermediate strength; heat-treated steels; metal behaviors as affected by hydrogen; powders and objects made by powder metallurgy; and severe service at high and low temperatures are just a few of the chapters contained in this book.

Transformer Engineering by L. F. Blume, A. Boyajian, G. Camilli, T. C. Lennox, S. Minneci, V. M. Montsinger; Second Edition; 500 pages; 6¼ by 9¼ in.; illustrated; cloth; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y.; 1951; price $7.50.

This second edition of this book on transformer engineering by a group of specialists of the General Electric Co. at Pittsfield, Mass., is a detailed study of every phase of transformer performance. It is designed to help the engineer solve the many technical problems involved in the specification, selection, application and operation of transformers.

Connections, phase angle, load ratio control, characteristics of insulating materials, co-ordination of insulation, thermal characteristics — these are just a few of the more important items covered in this splendid book. Recent advances in transformer engineering, particularly those relating to insulation, thermal characteristics and load ratio control practice, are included in this edition. For example, Chapter 9 on thermal characteristics has been completely rewritten. The complete data it provides will enable the engineer to obtain the maximum safe output under continuous overloads and under short time overloads with moderate sacrifice of life expectancy.

With clarity and usefulness as the guiding principles, overgeneralization at the expense of ease of application has been avoided and discussions of only academic interest have been omitted. Emphasis has been placed on presenting the essential physics concerned in each problem rather than giving a complete or exact mathematical treatment. Nevertheless, mathematics has been used as freely as seemed necessary for adequate solution of the various problems. The varied information and the co-operative effort that have made the writing of this book possible are the result of the association of the authors in the work of the Transformer Department of the General Electric Co. This department has for many years been a focus towards which technical problems, associated with transformers, have naturally gravitated. The book should perform a useful service to the electrical industry by bringing this information up to date and collecting it in convenient form.

Effective Teaching, A Manual for Engineering Instructors, by Fred C. Morris; 86 pages; size 6 by 9 in.; illustrated; flexible fiber cover; published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y.; price 60 cents.

Although this Manual is prepared primarily for the use of engineering instructors and is one of the best publications available on engineering teaching, at the same time it could very well be brought to the attention of teachers in many other fields. For it is one of the best and clearest discussions of the fundamental principles of teaching that we know of.

The Manual is not intended to convey the idea that all teachers should be cast in the same mold but emphasizes, on the contrary, that personality plays an extremely important part in teaching. This, however, does not bar the use of effective teaching methods and the book is designed only to give the first principles rather than the last word in teaching.

It begins by discussing the engineer and his responsibilities, the type of thinking he does, how he is educated and how a good teacher must go about doing this. Next is discussed the planning and organization of instruction; for example, designing the course to be an integrated whole.

Chapter 3 covers instructional aids, such as the blackboard, the projector and so on.

Chapter 4 tells how to conduct the class session. Chapter 5 talks about student learning activities, such as laboratory work, inspection trips and homework. Chapter 6 tells how to test the effectiveness of teaching. Chapter 7 covers the administration of instruction — that is, selection and training of teachers — and Chapter 8 gives a method of criticizing your own instruction work.

The book was written by Professor Morris, who is Secretary of Virginia Polytechnic Institute, aided by suggestions from the various members of the American Society of Engineering Education.

The book practices what it preaches by using a number of humorous but very apt illustrations to emphasize various points, by clear writing and by good organization.

We recommend the book here to engineers because nowadays many of them are giving instruction in inter-company training courses, in special night courses, in regular engineering colleges and tech-

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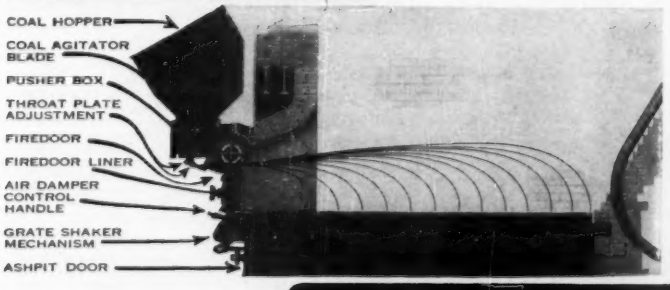

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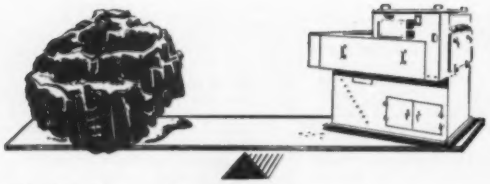

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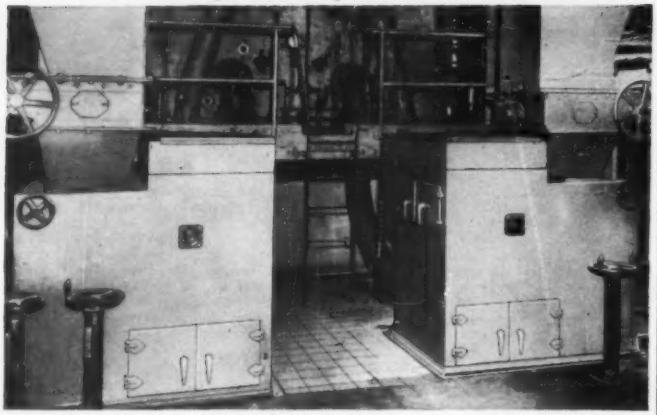

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nical schools, and in many other ways. They need exactly the same knowledge of fundamental teaching principles as the professional full-time engineering teacher. The latter knows all about Professor Morris' manual already. But for the practicing engineer who must teach in one way or another, this book should prove invaluable.

The present reviewer has been a teacher of engineering students and knows only too well his own defects, and the defects he has observed in many other engineering teachers. He can certify from his own experience that this book will tell you the things a good teacher does that produce results. The emphasis of the book is on how to do it right rather than on how *not* to do it. That, of course, is correct teaching psychology.

The Word Bank, compiled by Sophie Basescu; 190 pages; size 6 by 9 in.; cloth binding; published by Rodale Press, Emmaus, Pa.; price $3.00.

When you're writing a speech or a letter or an article, you must make your meaning clear by using the right word at the right time in the right place. This book is intended to help you find that word. The book is described as a brand new invention for instantly and positively locating the word that best suits your thought. It concentrates on the most important 75 per cent of the writer's vocabulary. Each word appears in a column of words of similar meaning and all are defined in the adjoining column by a simple phrase.

It is intended to offer a means of rapidly studying the various shades of meaning that distinguish every word from all the others related to it. This should strengthen your reading vocabulary as well as increase your fund of speaking and writing words.

The volume begins with a chapter on how to use The Word Bank. Then follows a scan key, listing words giving a general idea, followed by the key word in the idea, and the page on which to look for further information about this key word.

Part IV gives some interesting ideas of this kind on technical and scientific words, particularly in the medical and social sciences. The Word Bank ends with a list of useful prefixes and combining forms that are an integral part of the wealth of words in our English vocabulary.

This book is much different from a thesaurus and should be helpful to all writers, both technical and general.

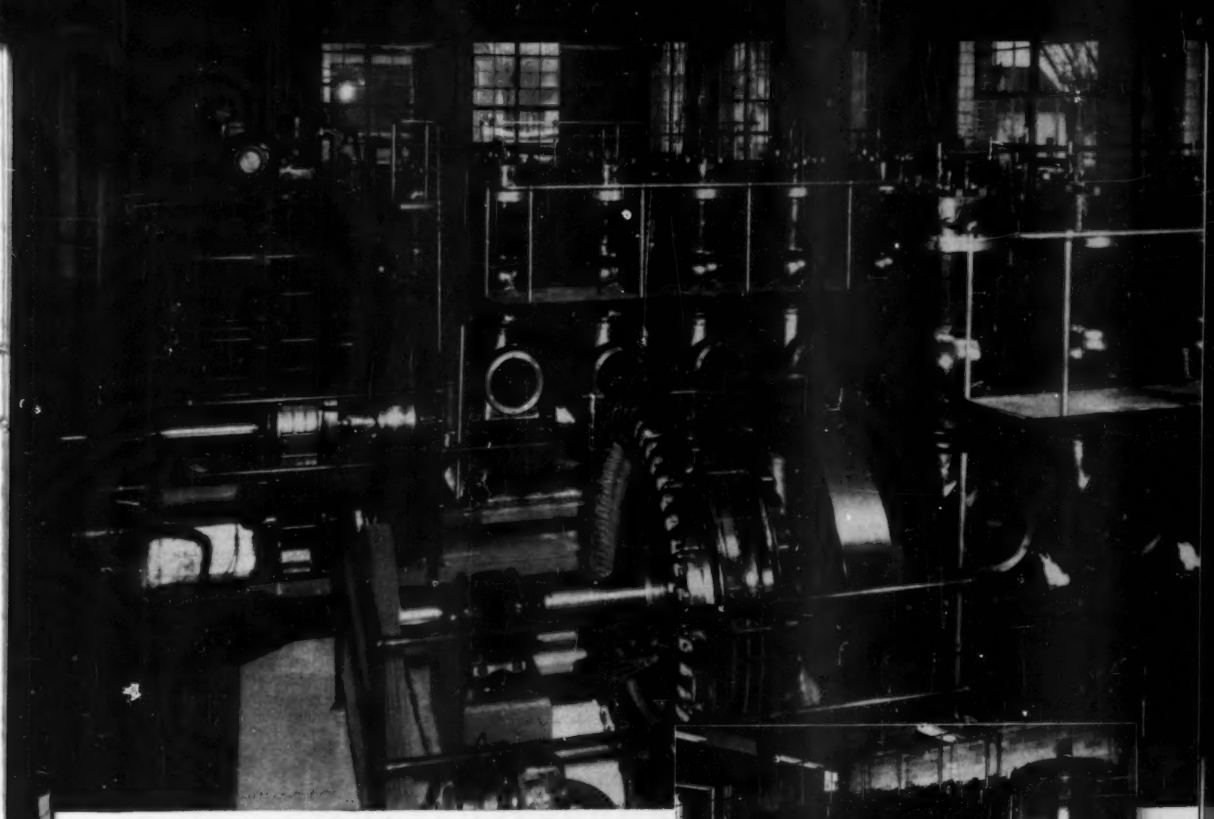
CATALOG LIBRARY

(*Continued from page 54*)

237 Valves, Fittings and Flanges — Catalog F-9 is a 400-pp, permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides ordering information on company's complete line, also much helpful engineering and application data; includes a section on products for refrigeration service. Fully illustrated, indexed. Available to qualified power engineers, please give your title. Henry Vogt Machine Co.

239 Pressure Reducing Valves — Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Northern Equipment Co.

240 Safety Valve Engineering Data — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, tables on superheat correction factor. Manning, Maxwell & Moore, Inc.



Above: Interior view of Municipal Light Plant, Madelia, Minnesota.

Right: T. C. Splinter, Superintendent (at right), checks performance of big diesel while S. C. Field of Standard Oil's Mankato office looks on.

Ailing diesels get clean bill of health

As power demands grew, so did trouble for the Municipal Light Plant of Madelia, Minnesota. Carbon formed rapidly in the plant's three diesel engines. Ports required cleaning every two to three weeks. Diesels had to be shut down frequently to free stuck rings and remove varnish from cylinder walls.

T. C. Splinter, plant superintendent, put the problem to a Standard Oil lubrication specialist. The lubrication specialist pointed out that the straight mineral oil used in the engines was not able to stand up under the severe conditions of operation. He recommended a switch to STANDARD HD Diesel Oil.

This heavy-duty lubricant made a clean sweep of the troubles. In four years of hard service, STANDARD HD has kept engines clean and rings free. Port carbon has been reduced to a minimum. Engines are now operated up to 8,800 hours before they are inspected or cleaned. Maintenance costs have been trimmed 30% to 40%.

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241 **High Pressure Gate Valve** — Described in 4-pp Form DH-273 is a forged steel gate valve designed for long service and low cost maintenance. Working pressures, sizes and prices listed. R-P & C Valve Div., American Chain & Cable Co., Inc.

243 **To Get at those Valves** — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

244 **Steam, Air and Gasoline Traps** — Catalog 751, 32 pp, is a 32-pp ordering book on traps. It's fully illustrated, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air, gasoline, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb. W. H. Nicholson & Co.

245 **Trap Data** — Here's a 12-pp condensed catalog giving information and prices on steam and air traps. Lists cast semi-steel and forged steel inverted bucket traps, compound steam traps, ball float air traps, Y-type strainers and internal check valves. Provides data on calculation of condensate loads and a selection of traps to handle these loads, also a full-page capacity chart. A parts list is included. Armstrong Machine Works.

246 **Steam Trap Reference Manual** — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure traps sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Also provided are installation and operating suggestions, prices. Yarnall-Waring Co.

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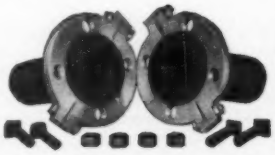

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249 **Safety Head Catalog** — Section 10, Part 1 of Catalog 54, 52 pp, is written in non-technical language and fully illustrated with cutaways and installation photos, charts and tables covering almost any phase of safety head information desirable. Tells where safety heads can be used and how to use them. Tells how to choose safety head assemblies and rupture discs. Includes tips for lowering temperature at point of safety head location. Black, Sivalls & Bryson, Inc.

250 **Design Properties of Pipe** — This 12-pp booklet consists of tables listing pipe sizes and wall thicknesses currently established as standard, plus what is believed to be a most complete tabulation of dimensional properties of commercially available sizes of steel pipe. Tube Turns, Inc.

251 **Piping Pointers** — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how-to-do-it features. Includes 8 pp valve selection guide. Crane Co.

252 **Handbook on Fittings and Flanges** Catalog wf-1950, 88 pp, gives working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings. Grinnell Co., Inc.

253 **Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

254 **Flanges for Severe Service** — This 4-pp bulletin describes a flange specially developed for services involving severe abrasion and corrosives, and for suction and discharge service. Goodall Rubber Co.

FUEL OILS, LUBRICANTS

255 **Fuel Oil Treatment** — By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and correction of these conditions by company's treatment. E. F. Drew & Co., Inc.

256 **Air Compressor Lubrication Manual** — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, safety precautions. Cities Service Oil Co.

257 **Diesels, Their Fuels and Lubricants** — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, also lubricating systems, and diesel oil purification and filtration. Includes discussion of fuel and lubricating. Sinclair Refining Co.

258 **Viscosity of Fluids** — The larger significance of viscosity is discussed in Nos. 5 and 6, Vol. 36 of Lubrication, a technical publication. In six parts, the first illustrates simplest conception of streamline flow between two surfaces having relative motion. A series of torsion viscometers shows how viscosity acts and may be measured. Part II covers streamline flow in capillary and other small tubes. Part III covers turbulent flow in pipes. Part IV discusses effects of temperature and pressure on viscosity, and Part V includes viscosity index. Part VI gives brief reference to nature of plastic flow. The Texas Co.

INSTRUMENTS AND CONTROLS

259 For Centralized Control — Bulletin 109 presents compact Mini-Line equipment suited to control board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes and illustrates vertical-scale indicator units, selector valve, remote manual relay. Bailey Meter Co.

260 Remote Reading Flow Meters — Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

262 Putting the Ratio Totalizer to Work — Twelve applications of company's ratio totaliser in automatic control circuits are shown in 8-pp Bulletin 5450. This is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Hagan Corp.

263 For Practical Men — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in long run economy. James G. Biddle Co.

265 Flow Tubes — Catalog 80, 4 pp, presents engineering data on a primary element for measuring, regulating, controlling fluid flow. Tells how flow tubes are designed, function. Foster Engineering Co.

266 Control Equipment — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Describes in detail: venturi tubes and meters, controllers, gages, manometers, pilots. Simplex Valve and Meter Co.

PACKINGS

270 Pump Packings — Packings for reciprocating and centrifugal pumps are described in this folder. Covers packings for practically all services. Johns-Manville.

272 Manual on Packings — Containing 84 pp of engineering and ordering information, Catalog 40 covers packings for practically every service. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

273 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

275 Packing Rings — Engineering data on company's Simsite Graphitic snap rings of non-metallic composition for packing liquid end pistons of reciprocating pumps is provided in illustrated Bulletin R112. Covers properties of Simsite, forms of packing spaces, ordering information needed, installation procedure. Sims Pump Valve Co., Inc.

COAL AND ASH HANDLING

276 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

278 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. Shows how beam system, electrical components and linkages are protected from exposure to coal dust. Richardson Scale Co.

281 Ash Handling Systems — This 24-pp booklet offers technical in-

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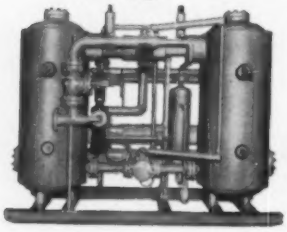

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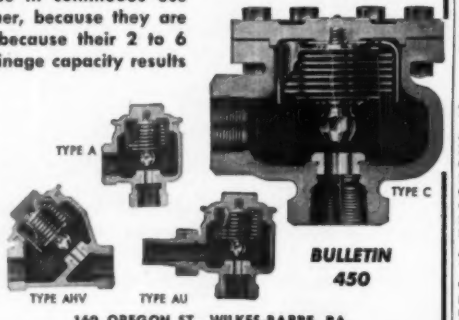

BULLETIN 450

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TRAPS · VALVES · FLOATS

formation on hydraulic and pneumatic ash and fly-ash handling systems. Compiled in question and answer form. Discusses elements and advantages of various systems and disposal schemes. Schematic drawings of arrangements under specific conditions, diagrams of arrangements included. Beaumont Birch Co.

282 Coal Handling Equipment — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

PUMPS AND COMPRESSORS

284 Compressor Selection Chart — Based on normal applications handling air with atmospheric intake pressure, this chart simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute. Shows recommended compressor bore and stroke in inches. Worthington Pump and Machinery Corp.

285 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major parts, floating seal incorporated. Capacity data, vapor pressure tables included. Pacific Pumps, Inc.

286 Controlled Volume Pumping — Illustrated Bulletin 151, 24 pp, on controlled volume pumping will be of interest to engineers whose plant operations call for pumping a controlled volume of liquid in amounts from 3 ml per hour to 50 gpm. Describes features of company's pumps and includes data for selecting pumps for specific applications. Milton Roy Co.

287 Data on Pumps — All Types — Bulletins are available on centrifugal, reciprocating, screw and rotary pumps covering a wide range of capacities and services. Includes information on single and multistage, close coupled, single and duplex piston, and special pumps for handling erosive and corrosive liquids, also high viscosity liquids, both lubricating, non-lubricating. Warren Steam Pump Co., Inc.

COOLING

291 Heat Exchangers — Bulletin 11.0-080 describes air cooled heat exchangers for condensing or cooling of steam or process vapors, natural gas, jacket water, lubricating oil, quenching baths. Equipment Div., J. F. Pritchard & Co.

294 Cooler with Fins — A new oil and water cooler and advantages of its improved design are described in 20-pp Bulletin 1020. Explains how company's LK-Fin Cooler, distinguished by use of helically-finned heat transfer elements instead of bare tubes, is a lighter, more compact and less costly unit. Diagrams show comparisons of length and number of tubes and size of units for equivalent heat transfer surface. The Griscom-Russell Co.

FANS, BLOWERS

298 Mechanical Draft Fans — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. Gives construction features, drive arrangements, mounting methods. The Green Fuel Economizer Co., Inc.

299 Blowers and Accessories — Engineering and dimensional information on low, medium and high capacity blowers is given in this 6-pp bulletin. Pictures some installations, also accessories. Blower-Stoker Div., Read Standard Corp.

300 Axial Flow Blowers — In this 6-pp illustrated bulletin are described axial flow blowers of both turbine-driven and motor-driven types. Gives capacity and dimensional data, operating range and specifications on both types. L. J. Wing Mfg. Co.

(*Continued on page 147*)

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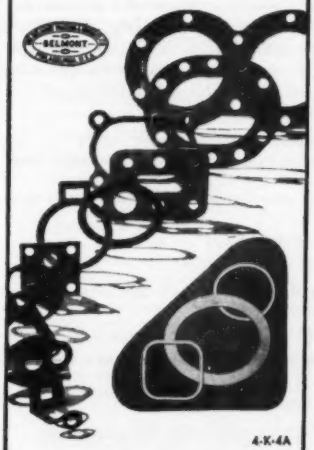

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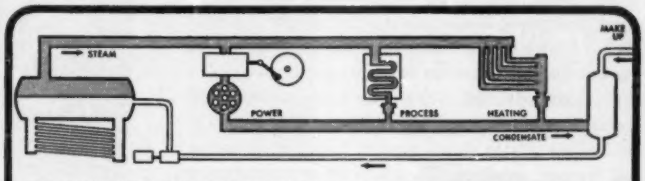

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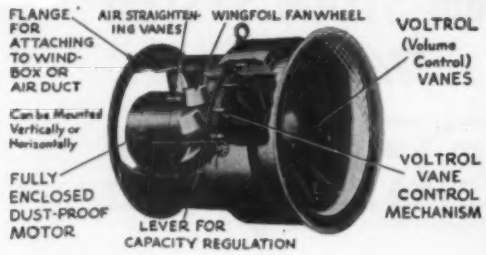
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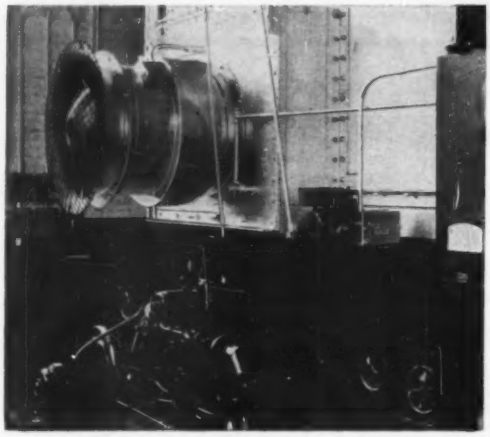

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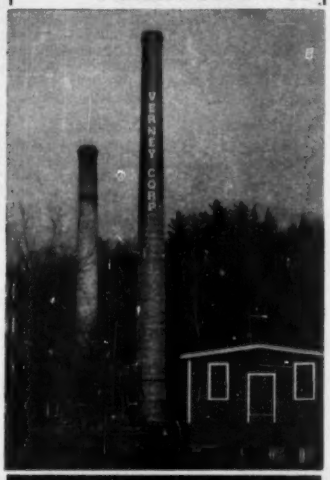

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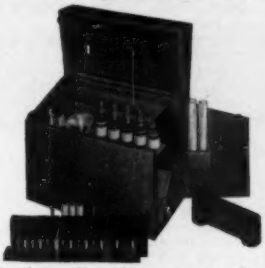

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302 Steam Condensers with Reserve Flow — Eight-pp Catalog 410-1 describes a "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate operation at partial load. C. H. Wheeler Mfg. Co.

303 Ejector Instruction Manual — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and maintenance of steam jet air ejectors. Discusses twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back pressures, steam nozzles, condensing water, raw water cooling, recirculation and removal of condensate. Foster Wheeler Corp.

304 Steam Condensers — Bulletin 102, 24 pp, presents manufacturer's steam condensers and includes photos of typical installations as well as engineering data, discussion of air removal equipment, and chapter on condenser maintenance. Company's Wizard injector to seal small leaks while condenser is in operation, air erosion eliminators, divers lights and port gages are also described. Condenser Service & Engineering Co., Inc.

METALS

305 Steels for Hot Spots — This is an 88-pp manual on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical properties of 21 steels. United States Steel.

306 Bibliography on Nickel Alloys — Sixteen-pp List A covers company's technical papers and commercial publications available on nickel alloy steels, stainless steels, nickel cast irons, nickel brasses and bronzes, and nickel plating, and their uses. The International Nickel Co., Inc.

OTHER EQUIPMENT

307 The ABC of CO_2 — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. Includes scales of total heat losses of various types of coal, fuel oils and gas. The Hays Corp.

308 Transmission Belting — Catalog M-9922, 28 pp, gives design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors included. United States Rubber Co.

309 Turbine Catalog Collection — This is a valuable collection of bulletins covering a complete description of solid wheel turbines. They feature cross section drawings of typical units for both moderate and high steam pressure conditions. Includes data on speed increasing and reduction gears. The Terry Steam Turbine Co.

310 Fly Ash Elimination — This 30-pp booklet presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash — not as a panacea for all cinder and fly ash problems. Also gives data on single and double hopper installations. Western Precipitation Corp.

311 Power Plant Equipment Guide — Twelve-pp Bulletin S-196-8, describing in condensed form company's line of power plant equipment, is profusely illustrated with photos, flow diagrams, dimensional drawings, performance charts and specification tables. Describes control valves, pressure master controls, desuperheaters, temperature master controls, water regulating valves, liquid level and drainage controls, differential pressure controls, feedwater heaters and regulators, separators, exhaust heads, other accessories. The Swartwout Co.

312 Dehydration Systems — This bulletin presents pressure type and gravity type dehydration systems for cleaning, stabilizing, and degasifying lubricating oils. Explains features, operation. Illustrated; includes specifications. Bowser, Inc.

314 Industrial Insulations — Selection and application information on insulating materials is presented in this 28-pp illustrated catalog. Covers block and blanket insulations, insulating cement, low pressure coverings, felt, other products. Gives specifications, temperature ranges, recommended thicknesses, prices; tells how to apply each type, where to use it. Baldwin-Hill Co.

315 Fundamentals of Hydraulics — Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance trouble-shooting and selection of proper fluids. Besides offering reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Sun Oil Co.

316 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomising oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomising the oil. Discusses steam and oil control valves, design and construction of furnaces in which fuel oil is burned, register and tandem types combustion units. National Airoil Burner Co., Inc.

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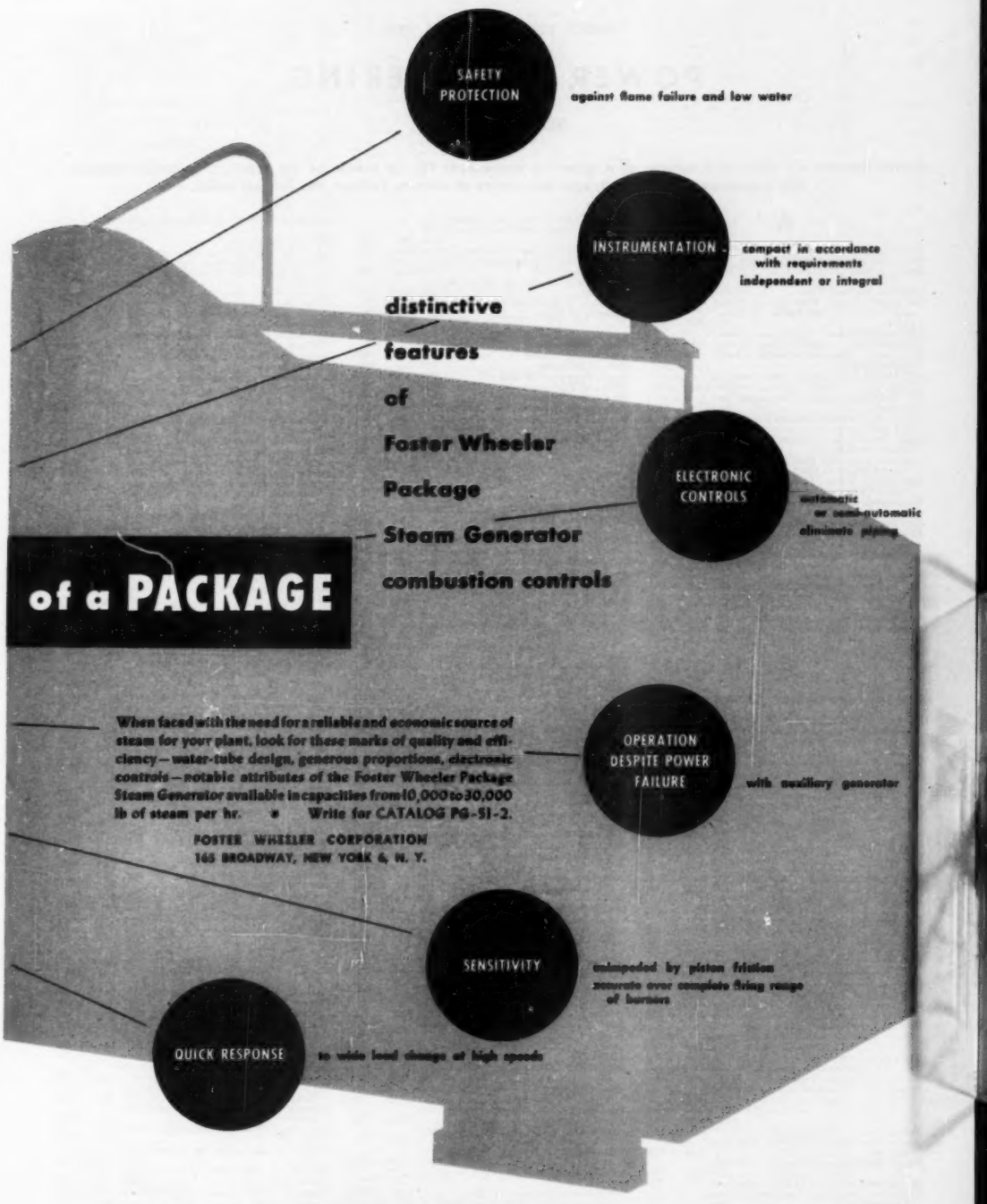
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Zeffren, Henry E. ..Mar 88
Ziemke, Paul C. ..Mar 80
..Aug 85

prevents wear on seats of

CHAPMAN

Tilting-Disc

CHECK VALVES

Here's the check valve with the balanced disc which is cushioned to a quick and quiet closure by the flow of gases or fluids as you can see in the cross-section at the right.

This smooth action prevents undue wear on seats, hinge pins and bearings . . . *and on your maintenance budget!* For there's no loosening of lines by vibration, no opened joints or ruptured pipes.

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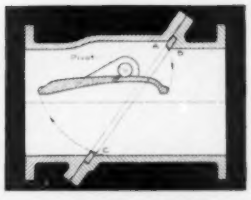
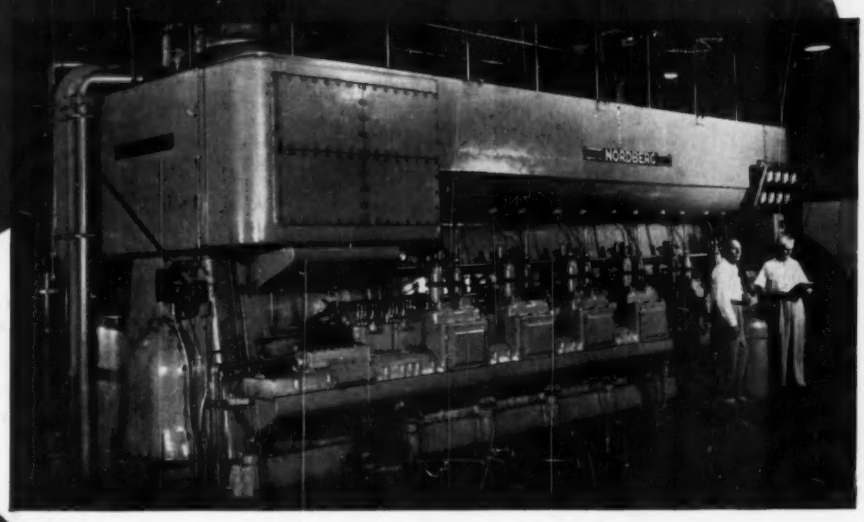
THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASSACHUSETTS



Cross-section of the Chapman Tilting-Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

65,000 HOURS OPERATION —WEAR NEGLIGIBLE



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